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HNF-6495
Revision B

Sampling and Analysis Plan for K Basins Debris

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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SAMPLING AND ANALYSIS PLAN FOR K BASINS DEBRIS

EXECUTIVE SUMMARY

This Sampling and Analysis Plan presents the rationale and strategy for sampling and analysis activities to support removal of debris from the K East and K West Basins located in the 100 K Area at the Hanford Site. This project is focused on characterization to support waste designation for disposal of waste at the Environmental Restoration Disposal Facility. This material has previously been dispositioned at the Hanford Low-Level Burial Grounds or Central Waste Complex.

The structures that house the basins are classified as Radiation Area/Contamination Areas. Therefore, all materials removed from the buildings are presumed to be radioactively contaminated. Because most of the materials that will be addressed under this plan will be removed from the basins, and because of the cost associated with screening materials for release, it is anticipated that all debris will be managed as low-level waste. Materials will be surveyed, however, to calculate radionuclide content for disposal and to determine that the debris is not contaminated with levels of transuranic radionuclides that would designate the debris as transuranic waste.

Debris that contains *Resource Conservation and Recovery Act of 1976* /Washington State dangerous constituents above regulated levels will designate as mixed waste. These constituents may be present at levels that require treatment to comply with Land Disposal Restrictions. Debris composed primarily of pieces greater than 60 millimeters that requires treatment for compliance with the Land Disposal Restrictions will be treated through macro-encapsulation as an approved alternative treatment technology for debris under Title 40, Code of Federal Regulations, Part 268, "Land Disposal Restrictions," Subpart 45. Treatment via macroencapsulation is generally cheaper than chemical analyses. Debris less than 60 millimeters will be treated as appropriate, based on *Resource Conservation and Recovery Act* constituents. Only a small amount of debris less than 60 millimeters is anticipated.

The sampling design for the debris uses facility or historical radiological sample data to establish the radionuclide/isotopic distribution of radiological constituents of concern. The radionuclide distributions are established for each waste stream and subsequently used to calculate the concentrations of the constituents of concern, indexed to cesium-137. The cesium-137 content of the waste will be calculated using data obtained from portable radiation dose-rate meters and gamma detectors. K Basin staff will use the correlation between surveys and individual radionuclide ratios to cesium-137 when evaluating data from radiological dose rate or gamma surveys to calculate radionuclide inventories for waste shipments.

In cases where assumptions used to establish historical radionuclide ratios are not applicable, contingency sampling and analysis may be required. Section 2.4 presents methods to obtain contingency laboratory analysis of the debris to measure specific isotopes to allow creation of appropriate isotopic ratios for a waste stream. Section 2.4 also includes use of nondestructive analysis as a contingency analytical approach. It must be emphasized that Section 2.4 is for contingency analysis and not routine use.

Analysis of the water from the basins and the inlet/outlet of the ion-exchange module will be used to determine the radionuclide content of the ion-exchange modules. Section 2.3 discusses the details of this approach and utilizes existing sampling and analysis processes.

Sampling and analysis plans for disposition of the K East Basin monoliths, sand filters and concrete wall and floor surfaces removed for disposal will guide characterization of these waste streams; therefore, they are not included in the sampling scheme discussed in this Sampling and Analysis Plan. Anomalous

waste, such as high-efficiency particulate air filters and air handling equipment, are described in this document as well as contingency sampling requirements for characterizing anomalous waste.

For painted debris and rags with stripped paint, the waste larger than 60 millimeters will be encapsulated, as allowed by the current regulations. No new characterization data is offered for this waste as historical data are available for the paint. The concentrations of *Resource Conservation and Recovery Act* constituents in the paint will be based on the entire mass of debris being disposed to assess whether the waste will be designated as *Resource Conservation and Recovery Act* hazardous. Waste smaller than 60 millimeters will be managed based on a determination of hazardous constituents.

This Sampling and Analysis Plan is based on the results of implementing the Data Quality Objectives process as documented in HNF-6273, *Data Quality Objectives Process for Designation of K Basin Debris*. The following topics are summarized in Section 1.0:

- Historical data
- Rationale for data collection, including surveys and sampling
- Results of the Data Quality Objectives process.

Section 2.0 includes the Quality Assurance Project Plan that includes details of the survey methods, analytical methods, detection limits, accuracy and precision criteria.

Section 3.0 includes the Field Sampling Plan that summarizes information needed by those collecting and shipping samples to the laboratory or those performing the surveys.

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ACRONYMS

ACM	asbestos-containing material
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
ARAR	applicable or relevant and appropriate requirement
ASME	American Society of Mechanical Engineers
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	Code of Federal Regulations
COC	contaminant of concern
CWC	Central Waste Complex
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FH	Fluor Hanford
GEA	gamma energy analysis
HEPA	high-efficiency particulate air (filter)
HIC	high integrity container
ICP	inductively coupled plasma
IWTS	Integrated Water Treatment System
IX	ion exchange
IXM	ion-exchange module
KBC	K Basin Closure (Project)
KE	K East
KW	K West
LDR	Land Disposal Restrictions
LLBG	low-level burial ground
LLW	low-level waste
MDL	minimum detection limit
MS	mass spectroscopy
NDA	nondestructive assay
NLOP	north loadout pit
NRCW	nonrestricted contaminated waste
PCB	polychlorinated biphenyl
PHMC	Project Hanford Management Contract

ACRONYMS (cont)

QA	quality assurance
QC	quality control
RA/CA	Radiation Area/Contamination Area
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	restricted contaminated waste
ROD	Record of Decision
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SNF	spent nuclear fuel
SOP	standard operating procedure
TBD	to be determined
TC	toxicity characteristic
TCLP	Toxicity Characteristic Leachate Procedure
TRU	transuranic
TSCA	*Toxic Substances Control Act of 1976*
WAC	Washington Administrative Code
WSCF	Waste Sampling and Characterization Facility

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) is focused on removal of debris from the K East (KE) and K West (KW) Basins and onsite disposal of debris at the Environmental Restoration Disposal Facility (ERDF). The document identifies the waste streams, as well as field survey and sampling approaches to be used to characterize the debris. The *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) *of 1980* Records of Decision (ROD) [*Declaration of the Record of Decision for DOE Hanford 100 Area* (EPA et al. 1999)] and *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (EPA 1999)] authorizes disposal of this waste at the ERDF if it meets that facility's waste acceptance criteria.

1.1 BACKGROUND

The KE and KW Reactors and their associated fuel storage basins were constructed in the early 1950s and are located in the Hanford 100 K Area near the Columbia River. The fuel basins are large, open-topped concrete pools, which contain demineralized water with dissolved radioactive contaminants and varied concentrations of suspended solids depending upon the underwater activities being performed. The basins were originally used to store spent nuclear fuel (SNF) from the KE and KW Reactors until the early 1970s, when these reactors were removed from service and the fuel removed from the basins. The Basins subsequently have been used to store SNF from the Hanford N Reactor. The KE and KW fuel basins held approximately 1,200 metric tons and 900 metric tons of N Reactor SNF, respectively; however, the SNF has now been removed from the basins and is stored in the Canister Storage Building.

The CERCLA ROD (EPA et al. 1999) for the K Basin defines debris qualitatively as all solid waste generated from the removal of materials from the KE and KW Basins, excluding SNF, sludge, and water. The project working definition of debris, as used in both the ROD and DOE/RL-98-66, *Focused Feasibility Study for the K Basins Interim Remedial Action*, is not to be confused with the *Resource Conservation and Recovery Act* (RCRA) *of 1976* definition of debris provided in *Washington Administrative Code* (WAC) 173-303-040 "Dangerous Waste Regulations" and Title 40, *Code of Federal Regulations* (CFR), Part 268, "Land Disposal Restrictions" (40 CFR 268), Subpart 2 (g). For purposes of establishing disposal requirements, RCRA defines debris as a solid material exceeding a 60 millimeter (mm) [2.36 inch (in.)] particle size. Thus, waste from the K Basins is subdivided into two categories, small particles (60 mm or less) that are subject to standard RCRA waste disposal requirements, and large debris (greater than 60 mm) that is eligible for disposal under the RCRA debris requirements. All project debris will be managed as required by the RCRA Land Disposal Restrictions (LDR).

The project does not anticipate that a significant quantity of the smaller material (<60 mm) will be generated. These items generally will be byproducts from larger debris items and will be managed with the related waste stream(s). Equipment that is not an integral part of the basin structures will be decontaminated as appropriate, removed from the basin, drained, packaged, and disposed of as debris.

Project debris includes items located both above and below the water in the basins, wastes generated from operation of the water and sludge treatment systems, and wastes generated during basin deactivation. Pressure washing and rinsing of debris will be used to remove the majority of sludge from the surface of debris removed from the basins. Pressure washing is defined as the minimal pressure [(nominally defined as greater than 40 pounds per square inch (>40 lb/in^2)] necessary to remove visible sludge from the debris. This approach will eliminate the majority of surface contamination associated with radionuclides, as well as polychlorinated biphenyls (PCB), and regulated metals associated with the sludge.

The Integrated Water Treatment System (IWTS) equipment and the structure in which it is installed will be removed, decontaminated as appropriate, packaged, and disposed as debris. Characterization of the IWTS, however, is not included in the sampling scheme discussed in this SAP. Sampling and analysis plans for disposition of the KE Basin monoliths, sand filters, and concrete wall and floor surfaces removed for disposal will guide characterization of these waste streams; therefore, they are not included in the sampling scheme discussed in this SAP. Additionally, characterization of the basin air handling systems is not included in this SAP.

Debris also includes aluminum and stainless steel fuel canisters in the basins, fuel racks, and miscellaneous piping, tools, hoses, scrap, and other materials. There were at one point in time over 7,400 canisters storing SNF in the K Basins.

Debris management will depend on the waste designation. Because the K Basin structures are designated as a Radiation Area/Contamination Area (RA/CA), all materials are anticipated to be low-level waste (LLW), unless they can be released through survey and analysis or the material is designated transuranic (TRU) waste. Debris might designate as LLW, mixed waste, TRU waste, or TRU mixed waste, depending on contaminant concentrations.

1.1.1 Previous Investigations

Debris has been grouped into discrete waste streams for this project. Summaries of the historical data for these waste streams are provided in the following paragraphs.

Mixed Waste Debris. No waste-specific radiochemical laboratory analyses have been performed to date on this waste stream. An estimate of the ^{137}Cs content of the waste was performed for past shipments using established dose rate-to-curie relationships (WHC-SD-WM-RPT-267, *Basis for Dose Rate to Curie Assay Method*; WHC-SD-WM-PROC-020, *Procedure for Categorizing and Inventorying Waste in Standard Containers*). Radionuclides considered reportable in previous waste shipments included ^{90}Sr, ^{137}Cs, $^{239/240}$Pu, ^{241}Am, and ^{241}Pu. This entire waste stream was designated as low-level radioactive mixed waste.

Inductively coupled plasma (ICP) total metals analysis Method 6010A (*Test Methods for Evaluating Solid, Waste Physical/Chemical Methods*, EPA/SW-846 as amended) have been performed on nine paint chip samples, as well as multiple chip samples from the overhead crane. Toxic metals (silver, arsenic, barium, cadmium, chromium, lead, and selenium) were confirmed to be present in paint chips at total concentrations greater than screening limits for the toxicity characteristic (TC) criteria.

Above-Water Waste. Radiochemical analyses for gross alpha, gross beta, ^{60}Co, ^{137}Cs, and ^{241}Am were performed on 20 105-KE smears. Nondestructive assay (NDA) analysis of 20 compacted drums and NDA of 4 boxes of waste was performed. Radionuclides in the resulting waste profiles included ^{90}Sr, ^{137}Cs, ^{152}Eu, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am, ^{241}Pu, and ^{244}Cm. This waste stream was designated as low-level radioactive waste with the exception of one barrel, which was estimated to potentially contain TRU waste. Nonradiological sampling was limited to the same paint chip samples used for characterizing the mixed waste debris. Some of this above-water debris also could be designated mixed waste.

Below-Water Debris. Radiochemical analyses were performed on coupons from pipes that were rinsed and removed from the basin. Analyses included total alpha, gamma energy analysis (GEA), $^{89/90}$Sr,

^{241}Am, and total uranium. Radionuclides that were found above detection limits included ^{137}Cs, ^{60}Co, ^{154,155}Eu, ^{90}Sr, uranium, ^{238}Pu, $^{239/240}$Pu, and ^{241}Am. In addition, NDA was used to evaluate 11 boxes of rinsed debris for maximum ^{137}Cs content. All of the waste was determined to be low-level radioactive waste.

PCB analysis was conducted on waters from the KE and KW Basins; PCBs were not detected using a minimum detection limit (MDL) of 0.5 µg/ml. Inductively coupled plasma analysis for total metals was performed on water samples from both basins. Although zinc, silicon, copper, and boron were detected in water samples, no TC metals were found above the TC levels, so the water is not a characteristic waste.

There have been three primary sludge sampling campaigns: floor and pit sludge from KE Basin, KE Basin canister sludge, and KW Basin canister sludge. Note that floor and pit sludge has not been sampled from the KW Basins. Because KW Basin fuel was better contained, and other operating conditions were similar to those in the KE Basin, the KE canister sludge is believed to be representative of KW sludge. With respect to Toxicity Characteristic Leachate Procedure (TCLP) testing, Washington State Department of Ecology (Ecology) and U.S. Environmental Protection Agency (EPA) agreed that test data from KE sludge samples could be used, in combination with KW sludge total metals data, to designate KW sludge. Based on knowledge of the materials and processes that generated the sludge, along with test data, the sludge streams are not regulated as hazardous waste under "Identification and Listing of Hazardous Waste" (40 CFR 261) or dangerous waste under WAC 173-303 [Letter 0101943/01-SFO-051 "Completion of Waste Designation for K Basins Sludge Waste Streams" (Loscoe 2001)].

Canisters. In 1996, several empty fuel canisters were pressure washed and removed from the basin for characterization (WHC-SD-SNF-TI-019, *Characterization of Empty Fuel Canisters in 105 KE Basin*). Smears were obtained from the canisters and submitted for GEA. The pressure-washed canisters were analyzed by NDA (gamma and neutron analysis) and an estimate was derived for the radionuclide content of the canisters. The NDA results indicated that the rinsed canisters were contaminated with ^{137}Cs, ^{60}Co, ^{241}Am, ^{154}Eu, ^{155}Eu, and ^{125}Sb [Internal memo 75745-FAST-96-050, "Analytical Report for K Basin Pipe – FT6021" (Lockrem 1996)].

From 2001 through 2004, approximately 4,000 canisters were removed from the K Basins and sent to the ERDF for disposal. In late 2004, a review of these waste shipments was conducted because of concerns regarding the weight-to-curie conversion method applied to the historical canister shipments. The dose rate and source term characteristics of the waste stream, particularly for aluminum canisters, appeared to have changed since the original characterization documented in Rev. 1 of this document and SNF-7895, *Documentation of K Basins Waste Determination Based on Cs-137 Concentration in Ci/Kg*. In addition, the waste stream was noted to meet the definition in Section 2.9 of Revision 1 of the SAP for "anomalous waste" due to its density being less than 0.2 g/cm^3 in the packaged form. Waste-specific modeling was conducted to determine an appropriate dose rate-to-curie conversion model for the packaged canister configuration. Contingency sampling was also conducted to determine the appropriate isotopic ratios to be applied to washed aluminum canisters. A series of metal coupons was collected from 12 aluminum canisters washed using the Canister Cleaning System process at 105-KW and analyzed for ^{137}Cs, transuranic radionuclides, and other isotopes as specified in Table 2-4. Results of the contingency sampling were used to derive the isotopic ratios provided in Table 2-2, Column 8.

For the remaining canisters in 105-KW, it is often not possible to determine the origin (105-KE or 105-KW) of each canister because the Fuel Transfer System was used to transfer fuel canisters from KE to KW from November 2002 through August 2004. For future canister waste, the new ratios (Table 2-2, Column 8) typically will be applied to aluminum canisters, and the KE/KW Below-Water Washed Metal ratios (Table 2-2, Column 3) will be applied to stainless steel canisters.

Asbestos and Asbestos-Containing Material. No radiochemical or chemical analyses have been performed.

Ion-Exchange Modules. The radionuclide content of the ion-exchange modules (IXM) was estimated from analysis of basin water and an assumption that 100% of the radionuclides, except tritium, measured in the water are removed by the IXM. Toxic metals were undetected in K Basin water (MDLs were less than TC levels); only zinc, silicon, copper, and boron were detected. The potential content of PCBs and toxic metals that may sorb onto the ion exchange (IX) resins was conservatively estimated based on the contaminants of concern (COC) being present in basin water at reported detection limits. These calculations used the mass of the entire IXM to estimate potential concentrations and assumed that 100% of the metals and PCBs were sorbed to the IX resin. The results showed that PCBs exceed *Toxic Substances Control Act* (TSCA) *of 1976* screening levels. Lower detection limits achieved for basin water samples collected in a one-time sampling event (May 2000) demonstrated that, for the RCRA metal constituents, the IXMs would not designate as hazardous waste. Analyses for PCBs were not conducted and instead, the IXMs will be designated as TSCA waste.

1.1.2 Contaminants of Potential Concern

PCB concentrations in paint are assumed to be below levels of concern for disposal at ERDF (concentrations are based on the total mass for the item, not merely the paint itself). Some items, such as fluorescent light ballasts, are assumed to have regulated PCBs and will be managed appropriately.

Painted debris, in general, will be assumed to not designate for metals, based on the total mass of the object(s). Based on the concentrations of TC metals that would be required to cause an object to designate as dangerous waste, it is concluded that this is a more efficient approach than sampling the painted debris for characterization. The same approach may be used for other small-volume suspect waste streams, such as light bulbs.

A diligent search was performed for specific waste streams to verify that there are no listed waste concerns.

Previous studies indicated that sludge is present in significant volumes in the KE Basin, resulting in potentially higher surface contamination concerns for debris from that location, due to contact with the sludge. Limited analysis of samples from the basins indicates the presence of PCBs in sludge from some locations. All debris will be pressure-washed and drained of free-flowing liquid as it is removed from the basins; after washing, the debris will not subsequently be regulated under TSCA, as approved in the CERCLA ROD (EPA et al. 1999). Debris that has been rinsed/washed must be visually inspected and field screened for radionuclides to confirm the effectiveness of this procedure for each piece.

The data quality objective (DQO) summary report prepared for debris presented the rationale for exclusion of constituents of potential concern (HNF-6273, *Data Quality Objectives Process for Designation of K-Basin Debris*). Table 1-1 provides the final list of COCs for each waste stream with the rational for inclusion. The logic for selection of the radioisotopes is presented in the DQO summary report. Any changes to the list of COCs and the rationale for these changes are included in the project files through the comment/ response process.

Table 1-1. Final List of Contaminants of Concern. (4 sheets)

WS No.	Material (Component)/ Category	COC	Rationale for Inclusion
1	Painted Debris	Radioactive COC list[a] TC metals –As, Ba, Cd, Cr, Pb, Hg, Se, Ag 2-(2-methoxy)-Ethanol, 2-Phthalocyanito-copper (copper phthalocyanine), 2,2,4-Trimethyl-1,3-pentanediol monoisobutyrate, 2-propoxyethanol, Dibutyl Phthalate, Naphthalene, Hydroxypropylmethylcellulose,	Radioactive COC list[a] Metals confirmed to be present in paint at concentrations above screening limits for TC. Nonvolatile paint constituents. Toxicity must be evaluated to determine the contribution to Dangerous Waste Criteria Equivalent Concentration per WAC 173-303-100 *NOTE: Volatile paint constituents identified in Table 1-5 (HNF-6273) for exclusion cannot be excluded without objective evidence, see Section 1.3.2 item 6 (HNF-6273).
2	Rags Contaminated with Stripped Paint Waste (Citristrip)	Radioactive COC list[a] TC metals –As, Ba, Cd, Cr, Pb, Hg, Se, Ag 2-(2-methoxy)-Ethanol, 2-Phthalocyanito-copper (copper phthalocyanine), 2,2,4-Trimethyl-1,3-pentanediol monoisobutyrate, 2-propoxyethanol, Dibutyl Phthalate, N- Naphthalene, Hydroxypropylmethyl-cellulose Methyl-2-pyrrolidone, D-Limonene	Radioactive COC list[a] Metals confirmed to be present in paint at concentrations above screening limits for TC. Nonvolatile paint constituents. Toxicity must be evaluated to determine the contribution to Dangerous Waste Criteria Equivalent Concentration per WAC 173-303-100. *NOTE: Volatile paint constituents identified in Table 1-5 (HNF-6273) for exclusion cannot be excluded without objective evidence, see Section 1.3.2 item 6 (HNF-6273). Citristrip constituents. Toxicity must be evaluated to determine the contribution to Dangerous Waste Criteria Equivalent Concentration per WAC 173-303-100 *NOTE: D-Limonene is a Washington "Toxic D" waste if present at 10% or greater.
3	Structural shielding that contains hazardous metals – lead bricks, lead shielding	Radioactive COC list[a] Pb	Radioactive COC list[a] Major component in lead shielding
4	Broken and intact fluorescent and incandescent light bulbs (ballasts/fixture assumed not present in the basin)	Radioactive COC list[a] TC metals –As, Ba, Cd, Cr, Pb, Hg, Se, Ag	Radioactive COC list[a] Metals present in fluorescent and incandescent bulbs

Table 1-1. Final List of Contaminants of Concern. (4 sheets)

WS No.	Material (Component)/ Category	COC	Rationale for Inclusion
5	Cartridge filters, disposable personal protective equipment, plastic, and other trash	Radioactive COC list[a]	Radioactive COC list[a]
6	Materials used for decontamination of equipment: cloth, paper, plastic	Radioactive COC list[a]	Radioactive COC list[a]
7	Process equipment: heat exchangers, piping	Radioactive COC list[a]	Radioactive COC list[a]
8	Unpainted demolition debris, structural steel, rocks, gravel, metal, glass, concrete, ceramic, bricks, roofing material, wood drywall, siding	Radioactive COC list[a]	Radioactive COC list[a]
9	Materials collected during general housekeeping: soil, sawdust, vegetation, debris, glass, plastic Soil added during D&D activities	Radioactive COC list[a]	Radioactive COC list[a]
10	HEPA filters	Radioactive COC list[a]	Radioactive COC list[a]
11	Structural steel – fuel storage racks & bulkheads; structures used for fuel handling	Radioactive COC list[a, b] PCBs, TC metals –As, Ba, Cd, Cr, Pb, Hg, Se, Ag	Radioactive COC list[a] Metals and PCBs have been identified in the KE Basin sludge, but do not meet the criteria for designation as hazardous waste under 40 CFR 261 or as a dangerous waste under WAC 173-303. The sludge is a PCB remediation waste as described in 40 CFR 761.
12	Process equipment – pumps, old canister washer, piping and piping components, rubber hoses	Radioactive COC list[a, b] PCBs, TC metals –As, Ba, Cd, Cr, Pb, Hg, Se, Ag	Radioactive COC list[a] Metals and PCBs have been identified in the KE Basin sludge, but do not meet the criteria for designation as hazardous waste under 40 CFR 261 or as a dangerous waste under WAC 173-303. The sludge is a PCB remediation waste as described in 40 CFR 761.

Table 1-1. Final List of Contaminants of Concern. (4 sheets)

WS No.	Material (Component)/ Category	COC	Rationale for Inclusion
13	Miscellaneous debris – electrical cables, light fixtures, long tools, brushes, personal protective equipment, metal, plastic, PCB transformers, electrical panels, batteries, PCB light ballasts, thermostats, door actuators, fire extinguishers	Radioactive COC list[a, b] PCBs, TC metals –As, Ba, Cd, Cr, Pb, Hg, Se, Ag	Radioactive COC list[a] Metals and PCBs have been identified in the KE Basin sludge, but do not meet the criteria for designation as hazardous waste under 40 CFR 261 or as a dangerous waste under WAC 173-303. The sludge is a PCB remediation waste as described in 40 CFR 761.
14	Canisters/canister lids	Radioactive COC list[a, b] PCBs, TC metals –As, Ba, Cd, Cr, Pb, Hg, Se, Ag	Radioactive COC list[a] Metals and PCBs have been identified in the KE Basin sludge, but do not meet the criteria for designation as hazardous waste under 40 CFR 261 or as a dangerous waste under WAC 173-303. The sludge is a PCB remediation waste as described in 40 CFR 761.
15	IXMs	Radioactive COC list[a] PCBs, TC metals –As, Ba, Cd, Cr, Pb, Hg[c], Se, Ag	Radioactive COC list[a] PCBs in water at concentrations at or near the reported detection limit may be expected to bind to the hydrophobic IXM resin material. Toxic Metals in water at concentrations at or near the detection limit may concentrate to elevated concentrations in the spent IXMs.
16	Floor tiles/ceiling tiles; sprayed on ceiling texture or acoustic surface coatings	Pb, if painted asbestos Radioactive COC list[a]	ACM may be painted. If lead paint is applied, ACM must contain less than 0.05% wt. paint. The age of the KE and KW Basin facilities indicates that asbestos is likely to be present in numerous materials. Radioactive COC list[a]
17	Pipe and duct insulation and insulation mastic; mastic used as adhesive for plastic baseboard moldings	asbestos Radioactive COC list[a]	The age of the KE and KW Basin facilities indicates that asbestos is likely to be present in numerous materials. Radioactive COC list[a]

Table 1-1. Final List of Contaminants of Concern. (4 sheets)

WS No.	Material (Component)/ Category	COC	Rationale for Inclusion
18	Mineral based building insulation in walls and ceilings	asbestos Radioactive COC list[a]	The age of the KE and KW Basin facilities indicates that asbestos is likely to be present in numerous materials. Radioactive COC list[a]
19	Asbestos board (transite) used in walls, ceilings, siding	asbestos Radioactive COC list[a]	The age of the KE and KW Basin facilities indicates that asbestos is likely to be present in numerous materials. Radioactive COC list[a]
20	High temp gaskets and seals	asbestos Radioactive COC list[a]	The age of the KE and KW Basin facilities indicates that asbestos is likely to be present in numerous materials. Radioactive COC list[a]
21	Oil, coolants, lubricants (used and unused)	Radioactive COC list[a] PCBs, TC metals –As, Ba, Cd, Cr, Pb, Hg[c], Se, Ag	N/A[d] Unless a hazardous waste or contaminated with radionuclide, these oils will be dispositioned as appropriate. Radioactive COC list[a]

Notes:

[a]Radiological COCs are ^{3}H, ^{60}Co, ^{63}Ni, ^{90}Sr, ^{125}Sb, ^{137}Cs/Ba, ^{147}Pm, ^{151}Sm, ^{152}Eu, ^{154}Eu, ^{155}Eu, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{241}Am, and ^{244}Cm. Each radionuclide has been included because they meet one or more of the following criteria (1) the radionuclide is part of the N Reactor uranium fuel cycle process, (2) the radionuclide is not gaseous and has a half-life greater than 1 year, (3) the beta/gamma emitting radionuclide was estimated to be present at greater than 1% of the ^{137}Cs activity of the waste, and/or (4) the alpha emitting or TRU radionuclide was estimated to be greater than 0.1% of the ^{137}Cs activity of the waste. The remaining radionuclides apply to all LLW from the K Basins. See HNF-6273, Appendix B, Table B-2.

[b]Radioactive/LLW could potentially designate as TRU or mixed waste if the sludge is incompletely removed, or if the underwater debris items are porous.

[c]Mercury was not detected in sludge; therefore, is not included.

[d]40 CFR 300.5

40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*, as amended.

40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions" *Code of Federal Regulations*, as amended.

HNF-6273, 2000, *Data Quality Objective Process for Designation of K-Basin Debris*, Rev. 0, Fluor Hanford, Richland, Washington.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

ACM = asbestos-containing material.
COC = contaminant of concern.
D&D = decontamination and decommissioning.
HEPA = high-efficiency particulate air (filter).
IXM = ion-exchange module.
KE = K East.
KW = K West.
LLW = low-level waste.
PCB = polychlorinated biphenyl.
TC = toxicity characteristic.
TRU = tranuranic.
WS = waste stream.

Lower detection limits achieved for basin water samples collected in a one-time sampling event (May 2000) demonstrated that, for the RCRA metal constituents, the IXMs would not designate as hazardous waste. Analyses for PCBs were not conducted and, thus, the IXMs will be designated as TSCA waste. Ion-exchange modules will be drained of free-flowing liquids and managed as debris in accordance with the ROD (EPA et al. 1999) definition of debris. The EPA has indicated that the unit includes the IX column and concrete shell and constitutes a high integrity container (HIC), which is equivalent to encapsulation (see HNF-6273, Appendix B). The project will proceed on this interpretation and the designation of the waste.

1.2 DATA QUALITY OBJECTIVES

Fluor Hanford (FH) Waste Management conducted a DQO Process to support the development of this SAP and determine the appropriate approach for characterizing the debris for disposal (TPA section 7.8).

The scope of the DQO (HNF-6273) included only characterization of debris from the K Basins and immediately adjacent areas, to allow the K Basins Closure (KBC) Project to assign appropriate waste designation. The scope included characterization for disposal of IXMs servicing the basin water and IXM's from the IWTS, but not the sand/granite filter. The DQO Process was conducted to provide the strategy for characterizing and designating K Basin debris to determine if it meets the ERDF waste acceptance criteria (BHI-00139).

As noted above, decisions that were documented through the DQO Process have, in some cases, been modified due to subsequent changes in project direction or based on discussions documented through the comment/response process. These changes are documented in project files and are noted, as appropriate, in summaries of the DQO Process provided in Sections 1.2.1 through 1.2.6. For additional details, refer to the DQO (HNF-6273).

1.2.1 Step 1: Statement of the Problem

Debris has been broadly defined by the K Basin ROD (EPA et al. 1999) as all solid waste generated from the CERCLA interim remedial action of KE and KW Basins excluding SNF, sludge, and water. The debris has been previously disposed at the Hanford Low-Level Burial Grounds (LLBG) or Central Waste Complex (CWC). This debris must be characterized and designated to allow disposal at ERDF or segregation for an alternate disposal pathway, as appropriate. Because the K Basin structures have been designated as a RA/CA, all materials removed from this area are assumed to be radioactively contaminated. Most debris will designate as radioactive LLW, although some may designate as radioactive mixed waste, TRU, or mixed TRU. Additional data are needed to designate the waste and evaluate whether it can be disposed of at ERDF.

Sampling and analysis plans for disposition of the KE Basin monoliths, sand filters, and concrete wall and floor surfaces removed for disposal will guide characterization of these waste streams; therefore, they are not included in the sampling scheme discussed in this SAP. Anomalous waste, such as high-efficiency particulate air (HEPA) filters and basin air exhaust equipment, are described in this document as well as contingency sampling requirements for characterizing anomalous waste.

1.2.2 Step 2: Identify the Decisions

Step 2 presents the logic pathway that is used to resolve the problem. Table 1-2 in the DQO (HNF-6273) presents the Principal Study Questions, Alternative Actions, and Decision Statements to resolve the problem that was presented above. Figures 1-1 and 1-2 present the decision logic, based on Step 2, which will be used to assess whether waste may be disposed of at ERDF. These figures have been modified in the course of the comment/response process.

1.2.3 Step 3: Identify Inputs to the Decisions

Step 3 identified the data needed to resolve each of the Decision Statements identified in Step 2, as well as the analytical performance requirements (e.g., practical quantitation limit requirement, precision, and accuracy) to support the data. The reader is referred to the DQO for the logic behind the selection of inputs, analytical methods and field techniques, and tables which present these information needs. Because process knowledge will be used to designate waste streams for TC metals, PCBs, and asbestos, no analyses will be conducted to support decisions related to these COCs.

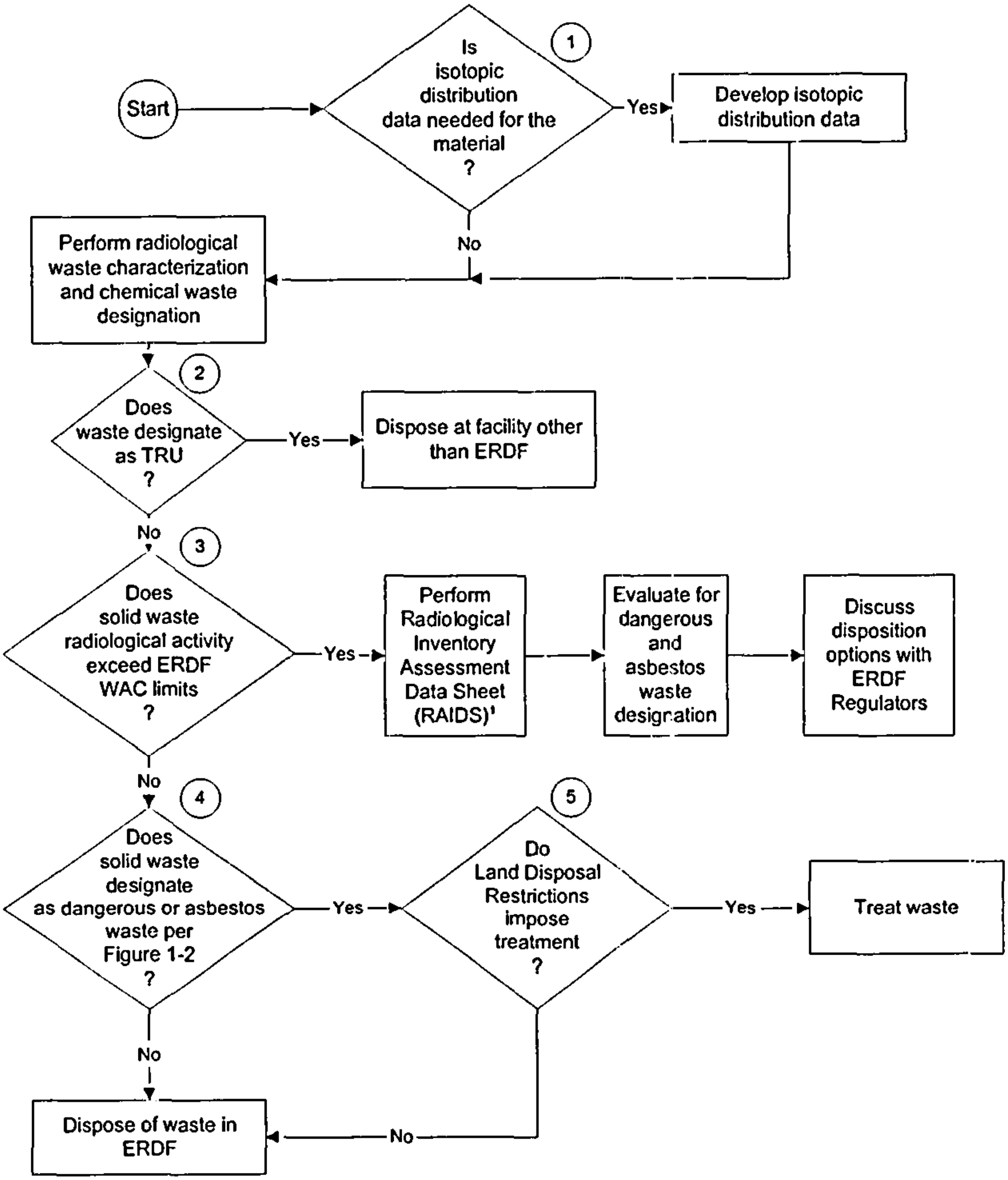
1.2.4 Step 4: Define the Study Boundaries

Step 4 identifies the geographic (spatial) and temporal boundaries of the facility under investigation, as well as practical constraints that must be taken into consideration in the sampling design. Table 1-5 in the DQO (HNF-6273) defines the attributes that make up each population of interest. The populations of interest described in this section have been revised slightly to indicate that painted debris will be assumed to not designate for TC constituents. The project at this time does not anticipate a need to encapsulate any painted debris. The project will develop a ratio that considers the painted surface area and mass of an item to determine the need for encapsulation of painted debris. Segregation of the waste will occur by visual inspection. This procedure will use existing data for TC constituents in paint and will be developed independently from this SAP.

The geographic area of investigation includes the structures that house the KE and KW Basins, as discussed in the ROD (EPA et al. 1999). Table 1-6 in the DQO (HNF-6273) defines the zones or materials within the facility under investigation that have certain similar characteristics.

Decisions for debris disposition (i.e., scale of the decision) will be made for individual articles of equipment, components, or other debris or consolidated packages of debris removed from the facility being investigated consistent with the applicable or relevant and appropriate requirement (ARAR) under which a decision is being made. Decisions for the IXM are based on the entire module.

The decisions identified in the DQO Process (HNF-6273) supporting this SAP apply to removal of all debris covered by the RODs (EPA et al. 1999) (EPA 1999) during K Basin remedial activities. Some of the later debris removal activities, particularly for those associated with decontamination and decommissioning of structures, are covered by the 100 Area Remaining Site ROD (EPA 1999). Other decontamination and decommissioning of structures are covered by other sampling and analysis plans including the KE Basin monoliths, sand filters, and concrete wall and floor surfaces removed for disposal; therefore, they are not included in the sampling scheme discussed in this SAP. Anomalous waste, such as HEPA filters and air handling equipment, are described in this document as well as contingency sampling requirements for characterizing anomalous waste. The large number of debris items and difficulty associated with collecting representative samples from the variety of matrices supports use of field radiological measurements over sampling and laboratory-based analysis of radionuclides for each item.



[1]KBC staff will provide the necessary inputs for the ERDF to perform calculations. It is not anticipated that the proposed waste will present any problems for tho ERDF inventory.

Figure 1-1. K Basin Debris Disposition Decision Logic.

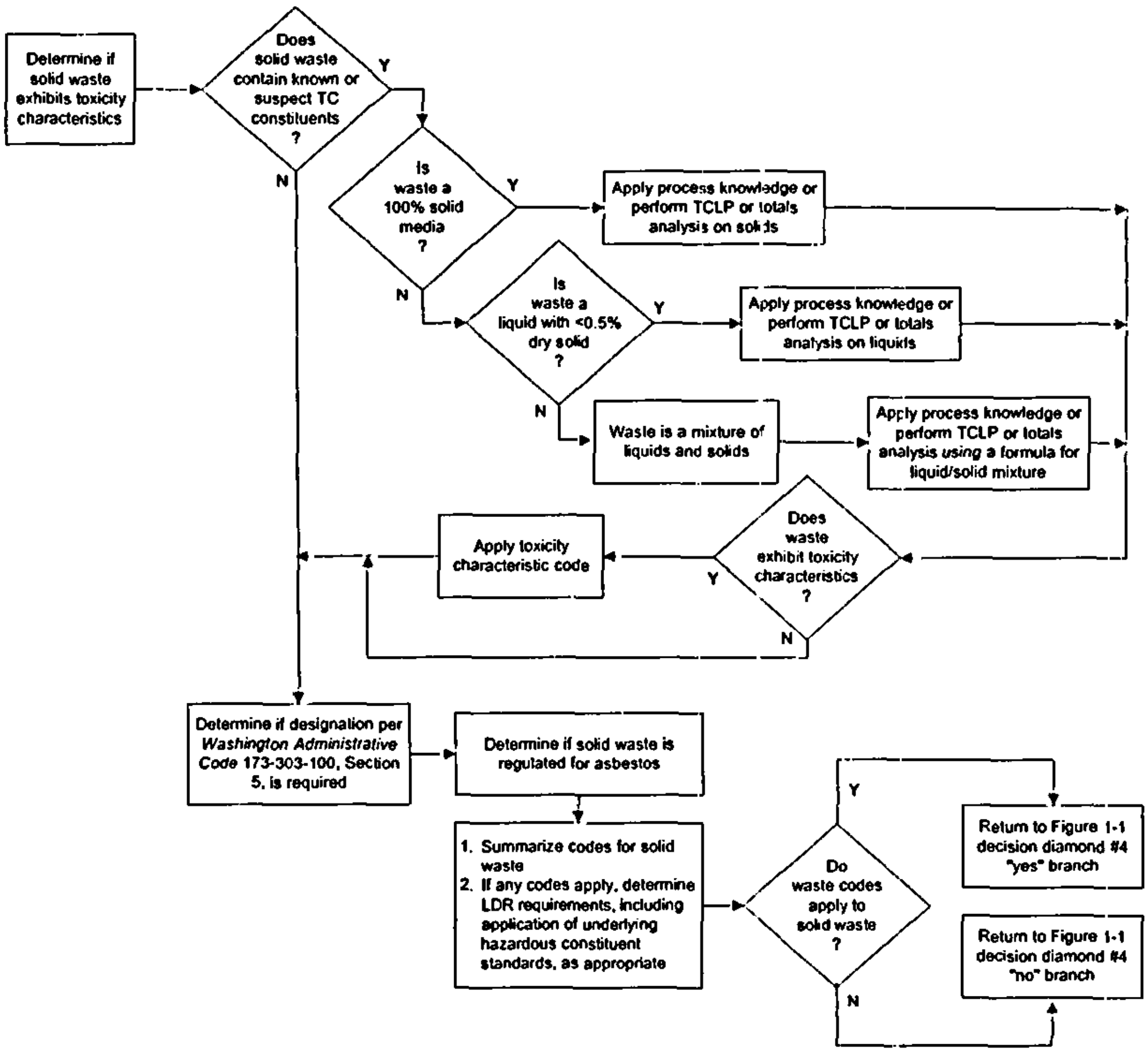


Figure 1-2. Chemical Waste Designation Decision Logic.

1.2.5 Step 5: Decision Rules

Step 5 combines information developed in DQO Steps 1 through 4 with a parameter of interest and an action level to provide a concise description of what action will be taken based on the results of data collected. Table 1-7 in the DQO (HNF-6273) lists the final action level for each Decision Statement and COC; this information has been incorporated into analytical performance requirements later in this SAP.

Table 1-2 (Table 1-8 from the DQO [HNF-6273]) combines the parameter of interest, scale for decision making, action levels, and alternative actions into separate "IF...THEN..." Decision Rules. These decision rules are the output from the DQO Process and describe actions that will be taken based on the results of data analysis.

Table 1-2. Decision Rules.

DR No.	Decision Rule
1	If the estimated* TRU COCs in the waste do not exceed 100 nCi/g, then the waste will be evaluated per DRs #2, 3, and 4 for disposal at ERDF. If the estimated TRU COCs in the waste exceed 100 nCi/g, then the waste will not be sent to ERDF.
2	If the estimated radionuclide COCs in the waste do not exceed the radionuclide ERDF waste acceptance criteria (BHI-00139) Ci/m^3, then the waste will be evaluated per DRs # 3, and 4. If the estimated* radionuclide COCs in the waste exceeds the radionuclide ERDF waste acceptance criteria (BHI-00139) Ci/m^3, then the waste will be evaluated on a case-by-case basis to determine if it may be sent to ERDF.
3	If process knowledge, or single sample concentrations of the detected analytical value, indicates that the materials <u>do not</u> designate as TC or exceed ERDF waste acceptance criteria (BHI-00139), then they will be packaged for disposal at the ERDF as LLW. Waste that designates <u>only</u> as Washington State dangerous will not require treatment before disposal. If process knowledge, or single sample concentrations of the detected analytical value, indicates that the materials designate as TC, state dangerous extremely hazardous waste, or exceed ERDF waste acceptance criteria (BHI-00139), then they will be managed through the appropriate treatment or packaging requirement and disposed of at ERDF.
4	If process knowledge or any detected analytical sample value dictates LDR imposed treatment, then debris materials as defined by RCRA will be treated with macro-encapsulation and disposed at ERDF. Materials that do not qualify as debris under RCRA will be managed appropriately according to their designation. If process knowledge or none of the detected analytical sample values dictate LDR imposed treatment of the materials, the debris will be disposed in ERDF without additional treatment.

Notes:

*Radionuclide content estimated from dose rate to curie conversions and other methods.

BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev 4, Bechtel Hanford, Inc., Richland, Washington.

COC = contaminant of concern.
DR = Decision Rule.
ERDF = Environmental Restoration Disposal Facility.
LDR = Land Disposal Restrictions.
LLW = low-level waste
TC = toxicity characteristics.
TRU = transuranic.

1.2.6 Step 6: Limits on Decision Error

This section of a DQO generally is used to establish the parameters for a statistically-based sample design. The SAP at this time does not anticipate that a statistically-based approach will be used. Debris will be evaluated through surveys of all materials, coupled with judgmental sampling, as appropriate. Refer to Step 6 in the DQO (HNF-6273) for additional details.

1.2.6.1 Radioactive Waste

Each waste container will be surveyed or will contain previously-surveyed waste. An estimated COC inventory for that waste container will be derived from survey data versus isotopic ratios from previous or contingency sampling measurements. The sample design is judgmentally developed for the materials or components that will ultimately be placed in the shipping container.

1.2.6.2 Potentially Chemically Contaminated Waste

No sampling for chemical constituents is currently planned for the debris. The Basin water flowing into the IXM currently is sampled routinely and the radionuclide load estimated (WHC-SD-SNF-EV-001, *105KE Basin PCB Wipe Sampling and Analysis*).

1.2.6.3 Paint Waste, Painted Debris, and Underwater Debris

Paint waste will be encapsulated; therefore, no sampling is needed to designate those wastes. The lead and cadmium inventory of painted debris, based on the ratio of the painted surface area to the mass of debris being disposed, will be used to designate the painted debris for appropriate disposal.

Debris removed from the basins will be rinsed and/or pressure washed to remove potential TC metals and PCBs. Previous studies have indicated that washing removes the metals and PCBs on debris that has been in contact with the sludge (Lockrem 1996). Calculations supporting these studies, which were part of a previous profile used for disposal at the CWC, are presented in Appendix D of the DQO Process (HNF-6273).

Some debris removed from the basins may be contaminated from sludge. Because of the radionuclide contamination, PCBs, and metals concentrations in the sludge, residual sludge could potentially cause debris to designate as mixed, TRU, or mixed–TRU waste. Accumulated sludge on the debris will be removed through a pressure wash, conducted under water. This procedure is presumed to reduce sludge and associated chemical contaminants to levels that are below regulatory concern. The removal of sludge will be assessed visually.

Lead bricks and shielding, debris designated as mixed waste, and debris that cannot be readily evaluated for compliance with LDR criteria after decontamination, will be designated as hazardous based on process knowledge, collected, and encapsulated for disposal at ERDF. Macro-encapsulation is a compliant alternative treatment technology for hazardous debris according to 40 CFR 268.45.

IXMs will be drained of free-flowing liquids and managed as debris in accordance with the ROD (EPA et al. 1999). The EPA has indicated that the unit, including the IX column and concrete shell, constitutes a HIC, which is equivalent to encapsulation (see HNF-6273, Appendix B). The project will proceed, based on this interpretation. Section 2.3 summarizes sampling frequencies and locations for collection of water used to calculate the constituent loading on the IXM. Table 1-3 summarizes sampling frequency and locations.

Table 1-3. Summary of Sampling Frequencies and Locations.

Material (Components)/ Categories	Sample Collection Methodology	Sampling Frequency	Sampling Location
All waste streams except fuel canisters and IXMs	Measurement of external dose rate, NDA, gamma spectroscopy, or sampling and laboratory analysis as appropriate to determine TRU and radiological COC content.	Debris for which an estimate of radionuclide content is desired.	Survey measurements will be performed on the waste packages, as described in Section 2.2.7. Measurements may be taken on individual debris items, or a suitable container of debris.
Fuel canisters	Measurement of external dose rate, NDA, or gamma spectroscopy to determine TRU and radiological COC content.	Fuel canisters may be measured individually or in larger containers, depending on final survey calibration availability.	Survey measurements will be performed on the waste, as described in Section 2.2.7. Measurements may be taken on individual debris items, or a suitable container of debris.
Water associated with IXM	None	Radionuclide load for each IXM will be calculated based on inlet/outlet IXM analytical data, length of IXM service and water flow rate information.	See Section 2.3

Notes:

COC = contaminant of concern.
IXM = ion exchange module.
NDA = nondestructive assay.
TRU = transuranic.

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2.0 QUALITY ASSURANCE PROJECT PLAN

2.1 PROJECT MANAGEMENT

2.1.1 Project and Task Organization

The project organization and responsibilities, as required by TPA section 7.8 and the EPA Requirements for Quality Assurance Project Plans (EPA/240/B-01/003)(EPA QA/R-5), March 2001 as revised, are described in the KBC Project execution plan (KBC-23617). Detailed responsibilities of those involved in all aspects of the sampling and analysis, from sample collection to disposition, including data generation and acquisition, assessment and oversight, and data validation and usability, are described in applicable implementing internal work requirements and processes.

2.1.2 Problem Definition/Background

The problem definition/background is discussed in Section 1.2.1.

2.1.3 Project/Task Description

The prime contractor [Project Hanford Management Contract (PHMC)] to the U.S. Department of Energy, Richland Operations Office (DOE-RL), or its approved subcontractors, will be responsible for collecting, packaging, and shipping debris. Detailed responsibilities of those involved in all aspects of the sampling and analysis, from sample collection to disposition, including data generation and acquisition, assessment and oversight, and data validation and usability, are described in applicable implementing internal work requirements and processes.

2.1.4 Quality Objectives and Criteria for Measurement Data

The quality assurance (QA) objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality. Data quality is typically assessed by representativeness, comparability, accuracy, precision, and completeness. Definitions of these parameters are described below. The applicable quality control (QC) guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. A summary of COCs for each media is provided in Table 1-6 of the DQO (HNF-6273). The analytical methods, laboratory detection limits, and sample size for COCs that will be measured are presented in Tables 2-3 for water samples that will be used to characterize IXMs. Table 2-4 provides the same information for contingency samples. The COCs that are not listed in these tables will be estimated based on radionuclide ratios in the waste as discussed in Section 2.2. Quality control parameters of accuracy and precision that are to be applied to water or contingency characterization samples are presented in Table 2-1. The nomenclature used to describe quality parameters is contained in the following discussion.

Representativeness is a measure of how closely measured results reflect the concentration of radiological constituents distributed in the sample matrix. Sampling plan design, sampling techniques, and sample handling protocols (e.g., storage, preservation, and transportation) have been developed and are discussed in subsequent sections of this document. The documentation will establish that protocols have been followed and sample identification and integrity ensured.

Comparability expresses the confidence with which one data set can be compared to another. Data comparability will be maintained by using standard documented procedures, consistent methods, and units. Fixed laboratory methods for analytes and target detection limits are listed in Table 2-4. Actual detection limits will depend on the sample matrix, constituent radionuclides, sample quantity available, and will be reported as defined for the specific samples. Detection limits are functions of the analytical method utilized to provide the data and the quantity of sample available for analyses. In the water and contingency sampling, sufficient sample quantity is expected to be available with sufficient radionuclide activity to perform the analyses.

Accuracy is an assessment of the closeness of the measured value to the true value. Accuracy of chemical test results is assessed by spiking samples with known standards and establishing the average recovery. A matrix spike is the addition to a sample of known amounts of a standard compound similar to the compounds being measured. Radionuclide measurements that require chemical separations use this technique to measure method performance. For radionuclide measurements that are analyzed by gamma spectroscopy, laboratories typically compare results of laboratory control samples against known standards to establish accuracy. Usually, only a few target analytes are selected for analysis for gamma spectroscopy (e.g., ^{137}Cs, ^{60}Co). Validity of calibrations are evaluated by comparing results from measurement of standard to known values and/or by generation of in-house statistical limits. Table 2-1 lists the accuracy targets for fixed laboratory analyses for the project.

Table 2-1. Target Accuracy and Precision of Laboratory Methods for Water and Contingency Sampling.[a]

Matrix	Accuracy for Radionuclides (Percent Recovery)[b]	Precision for Radionuclides (Relative Percent Difference)[c]
Solids	70 – 130 %	± 30%
Water	80 – 120%	± 20%

Notes:

[a] Accuracy and precision are based on published analytical methods for waste analyses (see Table-2-3).

[b] Percent recovery = ([amount measured in spiked sample-amount in unspiked sample] / spike added)*100.

[c] Relative percent difference = ([result 1 – result 2]/average result)*100.

Precision is a measure of the data spread when more than one measurement has been taken on the same sample. Precision can be expressed as the relative percent difference for duplicate measurements. Precision targets for fixed laboratory analyses are listed in Table 2-1. Monthly water samples are collected as a timed composite, and thus there may not be enough sample for a duplicate. If that is the case, precision will be estimated from laboratory matrix spikes or other suitable data.

Completeness is a comparison of the valid data required to the amount of valid data obtained from the analytical measurement process and the complete implementation of defined field procedures. The completeness objective for this SAP is set at 90%. Completeness will be assessed by waste stream on an analyte-specific basis. If the completeness objective is not met, additional samples will be collected and analyzed.

2.1.5 Special Training Requirements/Certification

Training and certification requirements are established in internal work requirements and processes that provide the training and qualification programs for project personnel who operate, support, or supervise KBC project activities and satisfy multiple training drivers imposed by the Project Contract Management Contract [including applicable CFRs, DOE Orders, American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) Standards and WAC requirements]. In addition, KBC Project site-specific health and safety plan, work packages, permits and job hazards analysis forms will provide additional training requirements.

In the event that a worker may have a reasonable possibility of exposure to hazardous chemicals while performing a specific remediation task in the K Basins, the Facility Operations Manager will ensure that the worker has the appropriate level of training, in accordance with "Occupational Safety and Health Standards" (29 CFR 1910), Subpart 120, "Hazardous Waste Operations and Emergency Response," before the work is performed.

All individuals who are required to have access to the K Basins radiological controlled areas shall be trained according to internal radiation protection work requirements and processes.

Job-specific training requirements for KBC Project personnel covers facility orientation training, Hanford General Employee Training, facility emergency plan, KBC Project orientation, initial and continuing training, on-the-job training, required reading and drills. The training requirements for each employee are determined using a graded-approach and documented in the appropriate training matrix.

All visitors, general employees, or members of the public, will have training or instruction prior to entry to the K Basins.

2.1.6 Documentation and Records

Field logbooks contain area and task-specific information. Field logbooks that are used during collection of samples for waste characterization will be identified as a quality record and will be maintained as such.

Documentation and records, regardless of media or format, are controlled in accordance with internal work requirements and processes that are comprised of a collection of document control systems and processes that use a graded approach for the preparation, review, approval, distribution, use, revision, storage/retention, retrieval, disposition and protection of documents and records generated or received in support of PHMC work.

2.2 SURVEY/DATA ACQUISITION

The following sections present the logic and requirements for radiological survey. The radiological dose rate survey data will be used to estimate radiological content of the waste. If the waste is determined to be anomalous (as defined in Section 2.2.3), it will be set aside and subjected to more extensive NDA and/or sampling and analysis. The approach for contingency sampling and NDA is discussed in Section 2.4 of this SAP. The sections below address requirements for instrument calibration and maintenance, and data management.

Waste generated at K Basins will be processed to comply with ERDF waste acceptance criteria (BHI-00139) and packaged according to internal work requirements and processes. Most of the waste removed from the basin water will be treated as restricted contaminated waste (RCW) because of several considerations. RCW is defined as a non-hazardous, radioactive waste that exceeds the following limits for loose/fixed contamination and radiation:

- Loose (smearable) surface contamination of 100,000 dpm/100 cm^2 beta-gamma or 400 dpm/100 cm^2 alpha when averaged over the entire surface of the material
- Fixed contamination of 75 mrad/hr/100 cm^2 beta-gamma or 80,000 dpm/100 cm^2 alpha when averaged over the entire surface of the material
- Radiation level reading of 50 mrem/hr beta-gamma when measured 30 cm from the surface.

This is in part a result of previous measurements of total and smearable contamination from the fuel canisters and pipe hangers washed and removed from the basin. These data indicate that the waste would not have passed the ERDF surface contamination criteria. It is also in part due to concern that it may be difficult to measure the loose and smearable contamination levels in the environs of the basin prior to wrapping the waste with plastic, putting it in a bag (or other method of fixing radioactive contamination) and maintain as low as reasonably achievable (ALARA) considerations. In addition, all of the surfaces of each individual piece of waste being removed from the K Basins may not be accessible. If large pieces of waste are encountered above the water, and all of the surfaces are accessible, some of the waste may be surveyed with portable handheld beta/gamma and/or alpha instrumentation and designated as non-restricted contaminated waste (NRCW) as appropriate. NRCW is defined as non-hazardous, radioactive waste that is less than or equal to the RCW limits. Such surveys will be conducted per the appropriate instrument procedure. RCW will be wrapped in plastic and placed in plastic bags. Other alternatives to plastic wrap (e.g., sprayed fixative) may be explored and used with ERDF agreement.

Packaged waste (e.g., individual pieces, bags, barrels, boxes as appropriate) will be surveyed per appropriate instrument procedures to assure that the outside of the waste debris package meets surface contamination limits, documented and weighed. The waste debris package will then be surveyed to obtain the dose rate (R/hr) from the waste package. The dose rate obtained from the waste package will be used to estimate the ^{137}Cs curie content of the waste as discussed below. Utilizing the ratios of the COCs to ^{137}Cs as discussed in Section 2.2.1, the radionuclide content of the waste will be calculated.

Any waste that is considered anomalous, per Section 2.2.3, will be set aside and may be measured with a more sophisticated NDA approach or sampled and analyzed in order to establish an appropriate radionuclide mix for the waste in question. These contingency/NDA sampling approaches are discussed in Section 2.4.

2.2.1 Dose Rate to Curie Conversion

The measurement of dose rate on the exterior of various sized containers can be related to an inventory of gamma-emitting radionuclides within the container, thus measurement of dose rate exterior to a container can be used to determine the container content of the measured radionuclide. The basic premise of most dose rate to curie methods is that the major contributor to the measured dose rate is ^{137}Cs. That premise is appropriate for the K Basin debris. Although other gamma emitters do exist in the K Basin debris, the most common (^{60}Co, ^{152}Eu, ^{154}Eu, and ^{155}Eu) generally are less than 10% of the ^{137}Cs content. By using the conservative assumption that all measured dose rate is from ^{137}Cs, other gamma-emitting radionuclides, if present, would lead to an overestimation of the ^{137}Cs content of the waste. All other radionuclides will be estimated based on use of specific ratios of COC radionuclides to ^{137}Cs. Thus, the final estimated radionuclide content would likely be overestimated if gamma-emitting radionuclides were present in greater abundance than anticipated.

Dose rate to curie conversion curves are developed specific to waste container configuration and content. A current list of dose rate to curie conversion curves that have been developed and will be used at the K Basins is:

- 4 by 4 by 8 ft. wood box
- 55-gallon drum
- 4 by 4 by 3 ft. wood or cardboard box center of face measurements
- 4 by 4 by 3 ft. wood or cardboard box hotspot measurements
- Soft waste roll-off
- Hard waste roll-off
- 10 by 9 by 20 ft. conex box.

It is recognized that additional dose rate to curie conversion curves will be used and developed as needed. The development and implementation of additional dose rate to curie conversion curves to those listed and other configurations is within the scope of this document. Only measurements performed on containers for which a dose rate to curie conversion curve exists may be used to estimate radionuclide content of the waste. A dose rate to curie curve for similar geometries may be used if the resulting ^{137}Cs concentration is overestimated. For example, the dose rate to curie curve for a 4 by 4 by 8 ft. wooden box could be used for a 4 by 4 by 4 ft. wooden box.

The implementation of dose rate to curie conversion curves will be accomplished via work instructions written based on the model used to develop the curves. The work instructions shall include at a minimum:

- The waste form or content to which the curve applies, as applicable
- The number and locations of dose rate measurements required to be collected
- The data collection documentation and recording requirements.

The work instructions shall control the data collection parameters that could affect the quality of the dose rate to curie conversion results. For example, a dose rate to curie model applicable to 4 by 4 by 3 ft. wood or cardboard boxes using center of face measurements was developed and described per HNF-23794, *K-Basin Canister Characterization Review Dose-to-Curie Method*. The work instructions controlling data collection supporting the example dose rate to curie conversion will specify:

- Recording the wood or cardboard box size of 4 by 4 by 3 ft. (may be identified by container number)
- Recording the box contents
- Recording uncorrected dose rate measurements as per Table 3-1
- Recording of the background dose rate
- Location of dose rate measurements as being the center of either 4 sides or all 6 box faces with all measurements collected at distances from the face at contact, 30, 100, and/or 200 centimeters.

2.2.2 Cesium-137 Curie to Radionuclide Content Estimate for Above-Water and Below-Water Debris

During the DQO Process, a final list of COCs was generated. The logic and approach for selecting the final list of COCs is discussed in Appendix B of the K Basin DQO (HNF-6273). The estimate of radiological content for waste will rely on ratios of various COCs to a measured ^{137}Cs content. The ^{137}Cs content will be estimated through dose rate to curie conversions that are discussed above. The ratios of various COCs to ^{137}Cs have been estimated based on review of available analytical data and computer calculations of estimated content of fuel and sludge from the KE and KW Basins.

The following sections were written prior to development of several key documents (HNF-SD-SNF-TI-015, *Spent Nuclear Fuel Project Databook, Vol. 2, Sludge*) that presented a clearer understanding of the K Basin sludge. The original discussion is retained in this section to provide the reader with a historical understanding of the decision making process. However, the reader is referred to Appendix A for a more thorough understanding of how the ratios were developed for this revision of the SAP. The following sections discuss the use of estimated ratios to characterize waste.

Below-Water Debris (Waste Streams 11-14) (HNF-6273). Fuel in both basins was the primary initial source of radioactive COCs in the water and in the basin sludge. The SNF experienced corrosion in the basin water through physical and chemical processes that resulted in the generation of corrosion products on the floor of the KE Basin as those canisters were open and some with screened bottoms. Corrosion of SNF in the KW Basin was evidenced in the corrosion products found when the canisters that had been closed were open. From a historical perspective the floor sludge in the KE Basin was a radiological source. The floor sludge in the KW Basin was not a radiological source as it was mostly environmental matter. However, the floor sludge became a radiological source during the course of cleaning and repackaging SNF in the KW Basin for removal and processing at the Cold Vacuum Drying Facility, and the transfer of SNF from the KE Basin to the KW Basin. In both the KE and KW Basin, it is assumed that fuel and sludge are the primary contributors to the radiological source term that contaminates the underwater basin debris.

For waste removed from beneath the water of the basins, available data indicate that the radionuclide mix remaining on fuel canisters and metallic waste (e.g., pipe hangers) would be similar (waste streams 11, 14, HNF-6273). Both will be washed prior to removal. Observed isotopic ratios from smears and NDA on washed metal items were approximated more closely by the radionuclide ratios estimated in the fuel (HNF-SD-SNF-TI-009, *105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities*, Volume 1, "Fuel") than in the basin sludge (HNF-SD-SNF-TI-009, Volume 2, "Sludge"). This was based on the evaluation of data from several documents in concert with analytical results and smears. Thus, the estimated or measured ^{137}Cs radionuclide content for KE and KW below water washed metal debris, with the exception of washed aluminum canisters, will be multiplied by the ratios in column 3 of Table 2-2.

The estimated or measured ^{137}Cs radionuclide content for KE and KW below water washed aluminum canisters will be multiplied by the ratios in column 8 of Table 2-2. The ratios for below water washed aluminum canisters were derived from HNF-23774, *Contingency Sampling Work Plan for K Basins Aluminum Canisters*. Twelve aluminum canisters were washed using the routine canister cleaning system process and metal coupon samples were collected from each canister. The coupons were sent to the 222-S Laboratory for radiochemical analysis to determine the ratio of various isotopes, specifically comparing transuranic radionuclides to ^{137}Cs. The contingency sample results were supplemented with decay-corrected KE below water washed metal ratios to develop the ratios in column 8, Table 2-2. If contingency sampling or NDA provides direct measurement of alternative radionuclide ratios, they will be applied. The data considered for this assessment and additional discussion are provided in Appendix A of this SAP.

For debris other than power-washed fuel canisters or metallic items (waste streams 12, 13, HNF-6273), it was determined that the basin floor sludge would be the appropriate source term. This was based on reasoning that those items such as rubber hose, animal/insect/plant parts, and other non-metallic debris would have been contaminated more by sludge particles lodging in the cracks of the material and washing would likely be much less effective than for the canisters and metallic waste. Thus, the estimated or measured ^{137}Cs radionuclide content will be multiplied by the ratios in column 4 for KE below water unwashed or non-metal debris [except KE North Loadout Pit (NLOP)] in Table 2-2. The KE below water unwashed or non-metal debris ratios represent a 40% canister/60% floor sludge mixture and are derived from the sludge databook (HNF-SD-SNF-TI-015) discussion on handling KE sludge mixtures. The estimated or measured ^{137}Cs radionuclide content will be multiplied by the ratios in columns 6 for KW below water unwashed or non-metal debris. The KW below water unwashed or non-metal debris ratios were derived from the sludge databook and are represented by the KE canister sludge ratios. The estimated or measured ^{137}Cs radionuclide content will be multiplied by the ratios, derived from the sludge databook, in columns 7 for KE below water unwashed or non-metal debris removed from the KE NLOP. If contingency sampling or NDA provides direct measurement of alternative radionuclide ratios, they will be applied. The data considered for this assessment and additional discussions are provided in Appendix A.

Activated metal debris may be characterized by using the dose rate to curie conversions in combination with the estimated mass of activated metal. The activated metal can be determined by visual observation in the basin. The mass of the activated metal is multiplied by the conversion factors from KBC-23699, *Estimate of Activated Metal in K East Basin Debris*. This will provide a conservative estimate of radionuclides because this method overestimates the ^{137}Cs concentration.

Waste Generated Above Water Near the Fuel Storage Basin (Waste Streams 1-10, 16-20, HNF-6273). For areas above the basin water surface it was reasoned that the contamination would have come from a variety of activities resulting in basin sludge and basin water being deposited during various operational activities. The sludge and water would dry and some part of the contamination would become airborne. Thus, it was reasoned that the air filter data obtained from both KE and KW Basins would be a useful measurement of the radionuclide ratios for contamination in the above-water portions of the basins. Available air filter data were summarized as a percent of ^{137}Cs and compared to ratios previously obtained by sampling and analysis (WHC-SD-NR-RPT-005, *Characterization of Radionuclide Waste at 100 Area*). Upon closer examination it was determined that the air filter data does not accurately reflect the above water contamination. Subsequently, the data from WHC-SD-NR-RPT-005 were used to determine the COC ratios. If no data were available for a specific radionuclide, then the sludge ratio was used. If there were no data for a specific radionuclide in the sludge, then fuel ratios were used. The KBC Project chose to use the KE above water ratios for both KE and KW basins based on transfer of KE fuel/canisters to KW and subsequent fuel cleaning. The final ratios for above water debris for KE and KW basins are listed in column 5 in Table 2-2. The KE above water debris ratios provide a worst case bounding condition for KE and KW above water debris. Thus, the estimated or measured ^{137}Cs radionuclide content will be multiplied by the ratios in Table 2-2 to estimate the radionuclide content of the waste. Appendix A provides additional discussion of this evaluation.

The KBC Project will evaluate monthly swipe sampling results on a quarterly basis on KE and KW above water debris to determine if the radionuclide COCs are within the baseline. The total alpha and total beta/gamma results will be compared to the baseline ratios.

2.2.2.1 Asbestos

Asbestos work, air monitoring, and worker safety requirements will conform to requirements (EPA 560-5-85-030A, *Asbestos in Buildings: Simplified Sampling Scheme for Friable Surfacing Materials*) for asbestos-containing material removal. If asbestos is identified, it will be surveyed and the radionuclide content determined the same way as discussed above for all of the other waste streams.

2.2.3 Anomalous Waste

Anomalous waste is defined as waste that is not expected to be consistent with the isotopic ratio for a described waste form in Table 2-2. For example, HEPA filters and radioactive air handling equipment radionuclide ratios are not expected to fall within Table 2-2, column 5, "Ratio for KE/KW Above Water Debris" and could be considered anomalous. Anomalous waste may require contingency sampling or NDA as described in Section 2.4. Alternately, existing process knowledge or analytical data may be used to develop radionuclide ratios. For example, historical air emissions data may be used to develop the radionuclide ratios for HEPA filters and radioactive air handling equipment. A known, over conservative, set of ratios from Table 2-2 could be chosen as long as the result over predicts the radionuclide content.

Table 2-2. Summary List of Radionuclide Contaminants of Concern and Ratios to ^{137}Cs for K Basin Waste.

Radionuclide Name	Radionuclide Symbol	Ratio for KE/KW Below Water Washed Metal Debris	Ratio for KE Below Water Unwashed or Non-Metal Debris (except KE NLOP)	Ratio for KE/KW Above Water Debris	Ratio for KW Below Water Unwashed or Non-Metal Debris	Ratio for KE Unwashed or Non-Metal Debris Removed From KE NLOP	Ratio for Washed Aluminum Canisters
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
Tritium	H-3	0.22%	0.23%	0.076%	0.23%	0.23%	0.22%
Cobalt	Co-60	4.8%	0.10%	0.058%	0.043%	0.84%	0.13%
Nickel	Ni-63	0.039%	0.038%	0.37%	0.38%	0.038%	0.039%
Strontium	Sr-90	76%	149%	102%	177%	38%	95.3%
Antimony	Sb-125	1.05%	0.067%	0.067%	0.067%	0.067%	1.05%
Cesium	Cs/Ba-137m	100%	100%	100%	100%	100%	100%
Promethium	Pm-147	0.69%	0.86%	0.86%	0.86%	0.86%	0.69%
Samarium	Sm-151	1.51%	1.5%	1.5%	1.46%	1.46%	1.51%
Europium	Eu-152	0.0058%	0.013%	0.013%	0.0096%	0.016%	0.0058%
Europium	Eu-154	1.95%	1.21%	1.21%	0.92%	1.56%	0.37%
Europium	Eu-155	0.97%	0.67%	0.67%	0.33%	0.39%	0.97%
Uranium	U-234	0.0083%	0.029%	0.030%	0.042%	0.037%	0.08%
Uranium	U-235	0.00030%	0.00087%	0.0052%	0.0013%	0.0014%	0.00%
Uranium	U-238	0.0068%	0.02%	0.024%	0.030%	0.030%	0.07%
Plutonium	Pu-238	1.03%	1.9%	2.26%	2.52%	4.24%	0.82%
Plutonium	Pu-239	2.13%	7.3%	14.6%	10.3%	21.1%	1.74%
Plutonium	Pu-240	1.12%	4.0%	4.0%	5.63%	11.6%	2.30%
Plutonium	Pu-241	44.1%	214%	174%	217%	489%	44.1%
Americium	Am-241	9.53%	9.3%	20.5%	15.7%	32.1%	5.2%
Curium	Cm-244	0.012%	0.025%	0.025%	0.042%	0.087%	0.012%

Notes:

KE = K East.
KW = K West.
NLOP = north loadout pit.

2.2.4 Suspect TRU Waste

In addition to consideration of the gamma ratios, any waste for which the estimated total TRU radionuclide content is greater than 100 nCi/g will undergo further evaluation including, but not limited to, contingency/NDA sampling, package specific dose rate to curie modeling, etc., in order to obtain a more accurate quantification of the TRU content obtained, or alternatively be manage as TRU waste. If a more precise measurement of TRU content of the waste is obtained, the contingency/NDA sampling results will be used. If a more precise measurement of the waste is not obtained or does not confirm that the waste is potentially TRU, alternatives to disposal at ERDF will be explored.

2.2.5 Dose Rate to Curie/Quality Control Requirements

The KBC Project will evaluate monthly results of smear samples collected above water throughout the KE and KW buildings to determine if the radiological conditions are changing adversely in the buildings. Each building is considered individually. The data will be reduced to a ratio of detected measurements of alpha to beta/gamma. Either or both monthly or weekly building survey reports may be used to obtain smear sample result data. The alpha to beta/gamma ratios for each month will be evaluated against the baseline at least quarterly. At a quarterly evaluation, if the alpha to beta/gamma ratio is found to exhibit a statistically significant increase in value relative to the baseline then radiological conditions in the basin building may be changing adversely and corrective action is required. A reduction in the alpha to beta/gamma ratio value relative to the baseline does not require corrective action be taken.

A baseline alpha to beta/gamma ratio for each basin building will be established using the monthly contamination survey data for each building collected for calendar 2004. The year 2004 is selected as baseline because it encompasses the time period that radionuclide ratios and conditions in each building were last evaluated by the project.

Corrective action will at a minimum require an evaluation of the data to determine the significance of an adverse change in conditions and actions to be taken to update the radionuclide ratios of Table 2-2 and building alpha to beta/gamma ratio baselines as necessary. The evaluation and corrective action undertaken will be documented. Waste may still be shipped to ERDF for the next three months if corrective action is required as long as a correction factor is applied that will account for the potential increase in actinides relative to beta/gamma emitters. Shipment of waste that is determined, when using this correction factor, to be close to the ERDF disposal limits will be restricted until completion of corrective action.

At the time that the endpoint criteria for removal of fuel, sludge, and basin water have been satisfied and the sand filter vessel, sand filter media, and all used ion exchange resin have been removed from the buildings, the quarterly monitoring of basin building radiological conditions will cease. At this point the sources of changes to radiological conditions will have been removed so continued monitoring will not be necessary.

The radionuclide ratios in this SAP will be decay-corrected every 3 years beginning in calendar year 2008.

2.2.6 Ion-Exchange Modules (Waste Stream 15, HNF-6273)

The IXMs will be characterized as described in Section 2.3. Radionuclide content will be estimated from the routine monthly analysis of basin water and the calculation of maximum radionuclide content based on the measured water values and the measured flow rates over the service life of the IXM column. The dose rate to curie conversion approach will not be used on the IXMs.

2.2.7 Radiological Survey Methods/Quality Control Requirements

Surveys of the surface of the waste packages will be performed to determine if waste packages can be removed from the initial staging area and placed in a bulk waste container. Radiological protection technicians perform surveys and obtain smears from the surfaces of waste packages (typically wrapped or bagged in plastic). It is anticipated that due to contamination levels on the waste and the general background in the bagging area, smears of waste package surfaces will be required before removal from the staging area. Appropriate scan speeds, survey techniques, and smear counting procedures will be used.

The dose rate surveys on waste packages will be used for calculating the ^{137}Cs curie content and subsequent estimate of other radionuclides. Data will be reported to appropriate K Basin staff on a Radiological Survey Report form.

2.2.7.1 Radiological Surveys

Radiological surveys of the outside of waste packages for radiological control purposes and to comply with ERDF waste surface contamination acceptance criteria will be performed and reported per internal work requirements and processes. Radiological surveys will be performed to measure gamma dose rate for subsequent estimation of ^{137}Cs content and to determine whether waste is anomalous.

2.2.7.2 Quality Control Requirements for Radiological Surveys

This characterization effort relies heavily on field measurements to extrapolate current estimated radionuclide ratios based on past laboratory and NDA analyses to waste in the KE and KW Basin areas. QA is necessarily built into each phase of the characterization as field instrument operational checks that monitor field instrumentation performance.

Alpha, beta/gamma surveys, gamma surveys and dose rate measurements will be used. Instruments will be calibrated against known standards representative of the instrument response to the identified analyte. The instrument will be within the calibration period specified by the instrument procedure.

Quality control measures taken to support field operations performance, include daily calibration checks, which will be performed and documented on each instrument used to survey or characterize waste. These checks will be performed as defined in the appropriate instrument procedure.

2.2.7.3 Instrument Testing, Inspection, and Maintenance Requirements

All onsite instruments used for waste characterization as described in Table 3-1 will be tested, inspected, and maintained in accordance with the manufacturer's operating instructions and in accordance with approved work packages. Results from all testing, inspection, and maintenance activities are documented in logbooks and/or work packages.

Analytical laboratory instruments and measuring equipment are tested, inspected, and maintained in accordance with the laboratories' QA plan. Daily response checks for radiological field survey instruments are performed in accordance with approved work documents.

2.2.7.4 Instrument Calibration and Frequency

All instruments used for waste characterization as described in Table 3-1 are calibrated in accordance with the manufacturer's operating instructions and internal work requirements and processes and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from all instrument calibration activities are recorded in logbooks and/or work packages.

Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratories' QA plan. Calibration of radiological field survey instruments on the Hanford Site is performed under contract by the Pacific Northwest National Laboratory on at least an annual basis, as specified in their program documentation.

2.2.7.5 Inspection/Acceptance Requirements for Supplies and Consumables

Supplies and consumables procured by PHMC, which are used in support of sampling and analysis activities, are procured in accordance with internal work requirements and processes, which describe the PHMC acquisition system and the responsibilities and interfaces necessary to ensure structures, systems and components, or other items and services procured/acquired for PHMC meet the specific technical and quality requirements. The procurement process ensures that purchased items and services comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

Supplies and consumables procured by the analytical laboratories are procured, checked and used in accordance with the laboratories' QA plan.

2.2.7.6 Field Survey Documentation

Field survey documentation will be kept in accordance with internal radiological survey requirements. Data used to characterize waste radionuclide content will be recorded as described in internal work requirements and processes for categorizing and inventorying waste in standard containers.

2.3 K BASIN WATER SAMPLING FOR ION EXCHANGE MODULE WASTE DESIGNATION

Process control water samples are collected weekly from the KE and KW Basins. The samples are analyzed at the KBC Operations Counting Facility for ^{137}Cs and total alpha. Samples are taken to detect changes in the water quality, and to maintain efficiency of the various filtration units. Data obtained are used to determine the ^{137}Cs removal efficiency and TRU inventory of the IXM so that the unit can be removed from service before the IX resin is depleted or the TRU limit is reached.

There are two separate and distinct basin water treatment systems in place that use IXMs. One system is the skimmer system, which takes water near the surface of the basin. This system has been in service for many years and there is existing process knowledge. This is IXM Position No. 4 for 105KW and IXM Position 1, 2, 3, and 4 at 105KE. The other system at 105KW is the IWTS, which takes water near the canister decapping station, washing machine, and dump table. These are IXMs Positions 1, 2, and 3 at 105KW. The approach that is discussed in this SAP is directed at IXM Position 4 at 105KW and IXM Positions 1, 2, 3, and 4 at 105KE, but a similar approach will be used for the IWTS IXMs in Positions 1, 2, and 3 at 105KW.

2.3.1 Sample Requirements

Samples are collected monthly from the center of the KE and KW Basins and the IXM inlet and outlet sample points and are analyzed at the Waste Sampling and Characterization Facility laboratory. Other analytical laboratories may be used when an appropriate letter of instruction, statement of work or contract is in place. The monthly center-of-basin water samples are collected for radiochemical analyses required to ensure compliance with Process Standard 400 and the IXM's inlet and outlet samples are collected as the primary radiochemical analyses for IXM characterization. The monthly center-of-basin sample may be used as a secondary source for the inlet data to an IXM if the inlet sampler is out of service. The samples are analyzed for gamma emitters (e.g., ^{137}Cs, ^{60}Co), as well as ^{241}Am, ^{238}Pu, $^{239/240}Pu$, uranium, tritium, and ^{90}Sr. The results from the IXM inlet/outlet samples are used to estimate radiochemical loading of the IXMs for waste characterization purposes. Based on the analytical results for a limited set of COCs, and estimated radionuclide ratios which relate the COCs that are not measured to those that are, the average concentration of the radionuclides in basin water is estimated for the time period that the IXMs were in service. Using the measured or design flow rates and length of service the radionuclide content of the IXMs is calculated.

2.3.2 Water Sample Handling and Custody Requirements

Sample handling, shipping and chain-of-custody requirements will be performed in accordance with internal work requirements and processes that provide instructions for safely packaging and shipping water samples.

2.3.3 Water Sample Preservation, Containers, and Holding Times

Water samples require acidification to pH of 2 for preservation for metal and radiological analysis and will be acidified at the time of sampling or at the KBC Operations Counting Facility, Waste Sampling and Characterization Facility (WSCF) Laboratory, 222-S Laboratory or another qualified laboratory. New plastic bottles (minimum one liter) will be used for collecting samples. The holding time for radionuclide analyses and metals is 180 days.

2.3.4 Water Sample Shipping

All sample containers will undergo field radiological screening to determine proper shipping and handling requirements. In addition, the monthly IXM inlet/outlet samples, including the IWTS monthly samples, will be sent to the KBC Operations Counting Facility for radiological screening prior to shipping. Sample management activities shall be performed in accordance with internal work requirements and processes that provide instructions for safely packaging and shipping low-level, low-level mixed, dangerous, and non-radioactive/non-regulated samples.

2.3.5 Analytical Methods Requirements for Water Samples

Fixed analytical laboratory parameters for water analysis are listed in Table 2-3. Laboratory-specific standard operating procedures (SOP) for analytical methods are in place. Laboratory SOPs and QA plans to be used include analytical procedures and QA plans from the WSCF Laboratory or equivalent procedures from other analytical laboratories. Changes or additional methods identified during future engineering or planning will be presented in page changes, addenda, or revisions to this SAP as appropriate. Detection limits achievable by the laboratory will be dependent on sample quantity available and may also be affected by the matrix and radionuclide activity levels of the sample.

Table 2-3. Water Sample Measurement Methods, Detection Limits, and Minimum Sample Volumes for Selected Radionuclide Contaminants of Concern.

Contaminant of Concern	Analytical Callout	Analytical Technique*	WSCF Laboratory	
			Detection Limits	Volume Requirements
			Liquid (pCi/L)	Liquid** (L)
Pu-238, Pu-239/240	Pu Isotopic	Alpha Energy Analysis	50	1
Am-241	Am Isotopic	Alpha Energy Analysis	50	1
Co-60	GEA	Gamma Energy Analysis	40	1
Sb-125	GEA	Gamma Energy Analysis	40	1
Cs-134	GEA	Gamma Energy Analysis	40	1
Cs-137	GEA	Gamma Energy Analysis	50	1
Eu-152	GEA	Gamma Energy Analysis	40	1
Eu-154	GEA	Gamma Energy Analysis	40	1
Eu-155	GEA	Gamma Energy Analysis	40	1
Sr-90	Total Radioactive Sr	Beta Counting	50	1
U-234, U-235, U-238	ICP/MS	ICP/MS	0.1 μg/ml	1
Pu-238, Pu-239	ICP/MS	ICP/MS	0.1 μg/ml	1
H-3	Tritium	Liquid Scintillation	20,000	1

Notes:

*An equivalent method may be used dependent on the laboratory performing the analysis.

** Minunum volume requirement

GEA = gamma energy analysis.

ICP = inductively coupled plasma.

MS = mass spectroscopy.

WSCF = Waste Sampling and Characterization Facility.

2.3.6 Laboratory Quality Control Requirements for Water Samples

Monthly center-of-basin water samples and monthly IXM samples are collected via a proportional sampler. Field duplicates are not collected.

Equipment rinsate blanks are not used for basin water sampling as bottles for collection of water are used once and disposed after analyses and no other equipment is used during water sampling.

Control measures taken to monitor laboratory performance are as follows:

- One laboratory method blank for every 20 samples (5% of samples), analytical batch or sample delivery group (whichever is most frequent) will be carried through the complete sample preparation and analytical procedure. The method blank will be used to document contamination resulting from the analytical process.

- One laboratory control sample or blank spike will be performed for every batch of samples for each analytical method criteria to monitor the effectiveness of the sample preparation process. The results from the analyses are used to assess laboratory performance.
- A matrix spike sample will be prepared and analyzed for every 20 samples (as applicable to method) of the same matrix or sample preparation batch, whichever is most frequent. The matrix spike results are used to document the bias of an analytical process in a given matrix.
- Laboratory duplicates or matrix spike duplicates will be used to assess precision and will be analyzed at the same frequency as the matrix spikes.

2.3.7 Instrument/Equipment Testing, Inspection, and Maintenance

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventative maintenance measures that ensure minimization of measurement system downtime and avoid inconsistencies in instrument performance.

Laboratories and onsite measurement organizations must maintain their equipment. Instrument preventative maintenance consists of routine inspections, instrument maintenance, and corrective actions. Preventative maintenance is performed in accordance with a schedule based on manufacturer's recommendations, instrument performance history, and usage. Each instrument has a logbook to record maintenance events with date and name of person performing the maintenance. The logbook includes routine inspections, significant corrective actions, instrument maintenance and repairs.

Spare parts inventories help ensure minimal loss of analytical capability. Spare parts include day-to-day consumables and manufacturer's recommended spare parts.

2.3.8 Instrument Calibration and Frequency

Laboratory measurement systems are subject to calibration and/or calibration verification before use for sample analyses. Calibrations are conducted in accordance with the specific analytical methods performed and in the applicable laboratory QA plan.

Instruments that fail acceptance criteria shall be investigated and recalibrated. Instruments are not allowed to be used for sample analysis until they meet acceptance criteria. The responsible chemist or manager is required to take corrective action when measurement systems fail calibration QC criteria.

2.3.9 Inspection/Acceptance Requirements for Supplies and Consumables

The quality of reagent water is monitored by a resistivity check, assessments of sample blank data, and monthly analysis performed by ion chromatography and ICP. Reagent water checks are described more fully in laboratory procedures or the laboratory QA plan.

Percent purity levels of gases or reagents necessary for quality analysis are listed in each analytical procedure. The quality of gases or reagents is monitored by performance of the preparation blank.

Standards that are prepared and used for the first time are verified against existing working standards or against an independent source to ensure accuracy of the standard.

The Standards Laboratory maintains records that provide traceability of the prepared standards to original standard reference materials.

Radioactive material standards are verified by preparing and counting mounts. The results of the count are compared to the calculated certified value.

2.4 CONTINGENCY ANALYSES

The purpose of contingency sampling and analysis or NDA is to verify radionuclide ratios. The purpose of verifying the radionuclide ratios may be to demonstrate that a waste is or is not anomalous. Contingency sampling may also be used if the waste is determined to be suspect TRU waste (dose rate to curie estimates indicate greater than 100 nCi/g TRU). Determination of anomalous waste is discussed in Section 2.2.3.

2.4.1 When Contingency Analyses/Nondestructive Assay will be Required

Contingency analysis or NDA may be required if the waste is determined to be anomalous as discussed in Section 2.2.3. Contingency analysis could also occur if the waste is designated as potential TRU waste utilizing the dose rate to curie conversion factors previously discussed. Before conducting contingency sampling, K Basin project staff will determine if there are cost-effective alternatives. If contingency sampling or NDA is chosen, then a specific work plan for sampling or performing NDA will be developed. Sections 2.4.2 through 2.4.9 discuss the anticipated approach to contingency sampling and analysis. Section 2.4.10 discusses the anticipated approach to contingency NDA. The details of the approach may vary depending on the selected vendor and specific waste to be sampled. Before conducting a contingency sampling effort, ERDF representatives will be consulted to ensure that the proposed process would provide acceptable data for waste designation.

2.4.2 Contingency Sample Locations, Handling and Custody Requirements

Waste that has been determined to require sampling will be staged in a controlled area while a work plan is written to sample the waste and a contract is put in place for the analyses. If contingency sampling is required, it will occur on a representative sample of the waste in the package that is being sampled. The purpose of the contingency sampling is to determine the appropriate representative radionuclide ratios to ^{137}Cs through radiochemical analysis. It is recommended that beta/gamma and/or alpha survey instruments be used to select a piece of the waste that exhibits a relatively high count rate. This will ensure that adequate contamination is available so the analyses will not be reported as "less-than values."

K Basin operators will be responsible for sample collection, packaging and shipment of samples to the 222-S Laboratory, WSCF, or other private laboratory. Before sampling, procedures will be written as part of a work package or work plan. The work package will include a detailed description (or reference an existing procedure) of the following activities:

- Sample identification
- Chain of custody
- Sample packaging

- Sample shipment
- Field logbooks.

2.4.3 Contingency Sample Preservation, Containers, Size, and Holding Times

Sample preservation is not applicable to these debris samples. Certified clean plastic or glass containers are not necessary for sample collection. Any clean container that is appropriate and available may be used. It is recommended that at least 200 g of sample be collected in two or more bottles. This will provide a backup sample if needed. The laboratory requires that the waste be cut into pieces of 1 to 2 in^2 each or less. It is recommended that final sample weight be discussed with the laboratory before obtaining the samples. Holding time for radionuclide analyses is 180 days.

2.4.4 Contingency Sample Shipping

All sample containers will undergo field radiological screening to determine proper shipping and handling requirements. Onsite transfers over nonpublic thoroughfares shall be performed in accordance with written procedures. The procedure includes requirements for proper monitoring and control of the radioactive samples and should be reviewed and approved by the Radiological Control Organization.

2.4.5 Analytical Methods Requirements for Contingency Samples

Fixed analytical laboratory parameters and methods for contingency samples are listed in Table 2-4. Laboratory-specific SOPs for analytical methods are in place. Laboratory SOPs and QA plans to be used include analytical procedures and QA plans from 222-S Laboratory. Other laboratories may be used. Changes or additional methods identified during future engineering or planning will be presented in page changes, addenda, or revisions to this SAP as appropriate. Detection limits achievable by the laboratory will be dependent on sample quantity available and may also be affected by the matrix and radionuclide activity levels of the sample.

2.4.6 Quality Control Requirements for Contingency Samples

This characterization effort relies on direct measurements to locate areas of higher beta/gamma contamination for subsampling requirements. QA is necessarily built into each phase of the characterization both as QC samples, which monitor sampling and laboratory performance, and field instrument operational checks that monitor field instrumentation performance.

Quality control measures taken to support field operations performance are described in Section 2.2.7.

Field QC samples will not be collected to support fixed laboratory analyses.

Table 2-4. Contingency Sample Measurement Methods, Detection Limits, and Sample Volumes for Selected Radionuclide Contaminants of Concern.

Contaminant of Concern	Analytical Callout	Analytical Technique Method Reference[a]	222-S Laboratory	
			Detection Limits[b]	Volume Requirements[b]
			Solid (pCi/g)	Solid (g)
Pu-238, Pu-239/240	Pu Isotopic	Alpha Energy Analysis	10	80
Am-241	Am Isotopic	Alpha Energy Analysis	10	80
Co-60	GEA	Gamma Energy Analysis	400	80
Sb-125	GEA	Gamma Energy Analysis	400	80
Cs-134	GEA	Gamma Energy Analysis	400	80
Cs-137	GEA	Gamma Energy Analysis	400	80
Eu-152	GEA	Gamma Energy Analysis	400	80
Eu-154	GEA	Gamma Energy Analysis	400	80
Eu-155	GEA	Gamma Energy Analysis	400	80
Sr-90	Total Radioactive Sr	Beta Counting	1.5	80
U-234, U-235, U-238	ICP/MS	ICP/MS	1µg/g	80
Pu-238, Pu-239/240	ICP/MS	ICP/MS	1µg/g	80

Notes:

[a]An equivalent method may be used dependent on the laboratory performing the analysis.

[b]Sample matrix will include 1 to 2 in. sections of metal coupons. The estimated mass for these sections is approximately 80g.

GEA = gamma energy analysis.
ICP = inductively coupled plasma.
MS = mass spectroscopy.

Control measures taken to monitor laboratory performance are as follows:

- One laboratory method blank for every 20 samples (5% of samples), analytical batch or sample delivery group (whichever is most frequent) will be carried through the complete sample preparation and analytical procedure. The method blank will be used to document contamination resulting from the analytical process.
- One laboratory control sample or blank spike will be performed for every batch of samples for each analytical method criteria to monitor the effectiveness of the sample preparation process. The results from the analyses are used to assess laboratory performance.
- A matrix spike sample will be prepared and analyzed for every 20 samples (as applicable to method) of the same matrix or sample preparation batch, whichever is most frequent. The matrix spike results are used to document the bias of an analytical process in a given matrix. It is assumed the matrix spike will be added after digestion.
- Laboratory duplicates or matrix spike duplicates will be used to assess precision and will be analyzed at the same frequency as the matrix spikes. Replicate analysis of the etching solution (digestate) of pipe coupons will be used to monitor precision where appropriate.

2.4.7 Instrument/Equipment Testing, Inspection, and Maintenance

See Section 2.3.7 for applicable criteria.

2.4.8 Instrument Calibration and Frequency

See Section 2.3.8 for applicable criteria.

2.4.9 Inspection/Acceptance Requirements for Supplies and Consumables

See Section 2.3.9 for applicable criteria.

2.4.10 Nondestructive Assay

Contingency NDA may be performed on waste that has been determined to be anomalous or suspect TRU. The K Basin Project staff will determine the efficacy of performing NDA on waste after consideration of disposal options, cost and schedule.

A primary purpose of the contingency NDA is to determine more accurately the gamma-emitting radionuclide mix of the waste. In addition, the NDA may employ neutron-counting instrumentation in order to obtain a more direct estimate of the TRU content of the waste. The NDA determination of gamma and/or neutron-emitting radionuclides will be on the entire waste package.

Waste that has been identified as anomalous will be staged in a controlled area while an NDA vendor is contacted. For NDA determination of radionuclide content of the waste, the vendor will supply collimated detector systems that are capable of identifying and quantifying gamma and neutron-emitting radionuclides in the waste. Before use, the vendor will supply PHMC with operational procedures, calibration procedures, estimated detection levels and assurances that the detection levels quoted can be met in the general background radiation fields present from the waste and surrounding areas. The vendor's procedures will be compliant with standard industry methods as described in NUREG/CR-5550, *Passive Nondestructive Assay of Nuclear Materials*, and ANSI N42.14, *Calibration and Use of Germanium Spectrometers for Measurement of Gamma-Ray Emission Rates of Radionuclides*, as appropriate.

2.5 ASSESSMENT/OVERSIGHT FOR SURVEY SAMPLING AND ANALYSIS

QA oversight requirements are described in the following sections.

2.5.1 Assessments and Response Actions

Surveillances and assessments are performed in accordance with internal work processes to verify compliance with requirements outlined in this SAP, project work packages, procedures, and regulatory requirements.

Correction of deficiencies identified during surveillances is addressed in accordance with quality improvement processes that satisfy basic fundamentals from the quality criteria expressed in "Nuclear Safety Management," (10 CFR 830) Subpart 122, "Quality Assurance Criteria," Item (c); and DOE O 414.1B, *Quality Assurance.*

2.5.2 Reports to Management

Management assessment results are reviewed and analyzed by management to identify and implement appropriate actions. Management assessment results are distributed to affected managers and deficiencies are managed per corrective action management internal work processes. An annual report to management shall include, at a minimum, an assessment of basin water quality samples and smear sample comparisons to baseline data.

2.6 DATA REVIEW, VALIDATION AND USABILITY

Requirements for review and evaluation of data usability are described in the following sections.

2.6.1 Data Review and Verification Requirements

Data verification will be performed on analytical data sets to assure that sampling and chain-of-custody documentation is complete, sample numbers can be tied to the specific sampling location, samples were analyzed within the required holding times, and analyses meet the data quality requirements specified in the characterization plan.

Analytical personnel and the project team will review the data. Laboratory personnel will perform a peer review of all analytical data. Peer review will be conducted by a person trained to the particular analytical method being reviewed. The laboratory will use its own data review procedures to review data before it is sent to the K Basin Project.

Project personnel or their designee will review the data and the summary QC with respect to the criteria in this SAP.

Survey measurement systems will be verified by a periodical review of the documentation to ensure that calibration checks are performed per the methods; dates of survey and analysis locations are properly documented. The review should be performed by program personnel.

2.6.2 Data Validation

Analytical and survey data will not undergo a formal validation.

2.6.3 Reconciliation With User Requirements

Following review, the laboratory data will be assessed by the project team against the criteria in Tables 2-1, 2-3, and 2-4. Assessment will include review of quantitative DQOs (e.g., accuracy, precision, completeness, and detection limits) and the preparation of a summary report. The final report will include an evaluation of the overall adequacy of the total measurement system with regard to the DQO of the data generated.

2.7 DATA QUALITY ASSESSMENT

Data quality assessment is performed by the project or project designee, after data review of the standard fixed laboratory data per Section 2.6. The review by the project or project designee must include evaluation of the method accuracy, precision, detection limits and completeness as required in Sections 2.1.4, 2.2.7, 2.4.5, 2.4.6, and 3.3.

The project DQOs will be reviewed including the conceptual model and any assumptions that are included in the data collection design. Because data collection for this project is not determined by a statistical design, hypotheses and error tolerances will not be included in the original DQOs. However, qualitative assessment of the fixed laboratory data and the survey data can be performed.

No statistical data quality assessment will be performed because (1) no random sampling is conducted, (2) only one sample and duplicate (if composite sample volume is adequate) will be collected for water, and (3) few samples from the same material will be collected for contingency analysis.

The estimated concentrations of radionuclides will be compared by the project to the applicable ERDF waste acceptance criteria (BHI-00139) for designation.

A report reviewing the data quality of field measurements will be prepared annually and provided to K Basin and Waste Services Management.

2.8 ANALYTICAL DATA REPORTS

The type of data report required by this SAP is a summary report with QA review. This report includes a case narrative and analytical QC, such as percent recovery on laboratory control sample, matrix spikes, relative percent differences (RPD) on duplicate or matrix spike/matrix spike duplicates and method blank results.

3.0 FIELD RADIOLOGICAL SURVEY AND SAMPLING OBJECTIVES

3.1 RADIOLOGICAL SURVEY OBJECTIVES

This section builds on the DQO Process developed previously (HNF-6273) and summarized in Section 1.0. The sections below summarize the radiological survey and sample design discussed in previous sections. The project objective is to remove all of the debris (e.g., pipe hangers, fuel storage canisters, miscellaneous tools, hoses) from the KE and KW Basins. The material removed will be washed to remove adhering sludge and disposed as waste debris. Waste from above the basin water line (e.g., protective clothing, cloth, light metal, concrete, ceramic, brick) will also be generated. As discussed in Section 2.2, radiological survey of the waste will be used as the primary tool to characterize the waste for disposal.

The objective of radiological survey is to characterize the waste with regard to radioactive COCs. The concentrations of COCs will be calculated from the measured dose rate and estimated ^{137}Cs content. If the waste is determined to be anomalous or is estimated to contain TRU at 100 nCi/g or more, it will undergo further evaluation including, but not limited to contingency NDA and/or sampling, package specific dose rate to curie modeling, etc., as discussed in Section 2.4 to obtain a more accurate quantification of the TRU content or alternatively by managed as TRU.

The objectives of the radiological survey of the debris are to estimate the inventory of radionuclides for disposal and identify and prevent disposal of prohibited waste as defined by the ERDF waste acceptance criteria (BHI-00139).

3.2 SURVEY LOCATIONS AND FREQUENCY

All waste will be surveyed for dose rates for the purpose of estimating the ^{137}Cs radionuclide content of the waste. The waste may be surveyed for surface contamination for purposes of designating the waste as NRCW or RCW.

Dose rate meter survey locations for purposes of obtaining an estimate of the ^{137}Cs content of the waste will be performed as directed in the appropriate work instruction. The survey will occur on each designated package of waste and consists of 6 to 14 measurements at predetermined locations. The measurements will occur in a relatively low background areas. The measured dose rate with or without subtracting background may be used to calculate Cs-137 content.

3.3 RADIOLOGICAL SURVEY QUALITY CONTROL

Radiological survey QC will consist of initial calibrations and operational checks in accordance with the applicable procedures discussed in Section 2.2.7.1 (see Table 3-1).

3.4 RADIOLOGICAL SAMPLING OBJECTIVES AND REQUIREMENTS

The objective of radiological contingency sampling for this project is to provide data to confirm (or establish appropriate) radionuclide ratios for anomalous waste as discussed in Section 2.2.3. Contingency sampling may also be employed to more accurately characterize suspect TRU waste as discussed in Section 2.4.1.

The objective of the water sampling, as discussed in Section 2.3, is to provide data for use in characterizing IXMs that have been taken out of service.

Table 3-1. Radiological Survey Instrumentation Quality Control Requirements. (2 sheets)

Data Type	Survey Method and Purpose	Analyte	Typical Instrument	Preliminary Action Level	Detection Limit Requirement	Accuracy Requirement (% of True Value)[a]	Precision Requirement (%RSD)[b]
Dose Rate	Dose rate measurement for R/hr to curie ^{137}Cs conversion and for determination of restricted and nonrestricted waste classification	Gamma-emitting radionuclides[c]	Eberline RO-20, Ionization Chamber	50 mR/hr at 30 cm from surface: 75 mR/hr at surface	0.5 mR/hr	Within limits printed on source check assembly	20%
^{137}Cs and Gross Gamma Activity	Portable in-situ gamma survey for identification of anomalous waste	Gamma-emitting radionuclides	Eberline 2221 or equivalent with 3 x 3inch NaI detector	Various depending on radionuclide	Various depending on radionuclide	80-120 typically from operational calibration	20%
Alpha Activity	Alpha Scintillation for determination restricted and non restricted waste	Alpha-emitting radionuclides	Bicron Surveyor X with a Scintillation Detector	Fixed Activity: 80,000 dpm/100 cm^2 Smears: 400 dpm/100 cm^2	Fixed Activity: <80,000 dpm/100 cm^2 Smears: <400 dpm/100 cm^2	Within limits printed on source check assembly	20%
Beta/gamma activity	Beta/gamma pancake Geiger-Mueller (GM) for determination restricted and non restricted waste	Beta-emitting radionuclides[d]	Bicron Surveyor X, or Eberline E-140 Series with a pancake GM detector.	Fixed Activity 900,000 dpm/100 cm^2 Smears: 100,000 dpm/100 cm^2	Fixed Activity <900,000 dpm /100 cm^2 Smears: <100,000 dpm/100 cm^2	Within limits printed on source check assembly	20%
Gamma activity	NDA gamma analysis for determination of radionuclide content of waste	Gamma-emitting radionuclides	Collimated gamma detector, multi-channel analyzer.	45 nCi/g ^{137}Cs[e]	< 45 nCi/g ^{137}Cs	80-120	20%
Neutron activity	NDA thermal neutron analysis for determination of TRU radionuclides	TRU radionuclides	Collimated neutron detector	100 nCi/g TRU	TBD[f]	80-120	20%

Table 3-1. Radiological Survey Instrumentation Quality Control Requirements. (2 sheets)

Data Type	Survey Method and Purpose	Analyte	Typical Instrument	Preliminary Action Level	Detection Limit Requirement	Accuracy Requirement (% of True Value)[a]	Precision Requirement (%RSD)[b]

Notes:

[a] Source check must be within these limits per applicable procedure.

[b] Multiple source checks must within 20% of each other.

[c] Although the instrument is capable of measuring the dose from a wide variety of gamma and beta emitting radionuclides, for purposes of this SAP, the measurements will be made with the window closed and all of the dose will be ascribed to ^{137}Cs.

[d] Although the instrument is capable of measuring gamma emitters with a very low efficiency the response of the instrument will be assumed to be entirely from beta emitting radionuclides.

[e] If the waste is such that the radionuclide ratios for KE Basin above water waste are applied, the estimated TRU content of the waste is about 0.4 times the measured ^{137}Cs activity. Thus, if the method can detect 45 nCi/g ^{137}Cs, then the estimated TRU content would be about 20 nCi/g.

[f] Acceptable detection limit for neutrons will be such that the detection limit of TRU in waste is equivalent to <50 nCi/g TRU based on estimated TRU content of KE and KW Basin sludge or fuel as appropriate to the waste being measured.

GM = Geiger-Mueller.
KE = K East.
KW = K West.
NDA = nondestructive assay.
RSD = relative standard deviation
TBD = to be determined.
TRU = transuranic.

4.0 HEALTH AND SAFETY

All field operations required by this SAP will be conducted in accordance with the requirements found in DOE policies (DOE P 450.4, *Safety Management System Policy*; DOE P 450.5, *Line Environment, Safety and Health Oversight*; and DOE P 450.6, *Secretarial Policy Statement - Environment, Safety and Health*). These policies and standards make up an integrated environmental, safety, and health management system.

The management system identifies processes and procedures where the primary hazards associated with debris waste management activities are managed. Some of the hazards included direct radiation exposure, potential personnel contamination, potential inhalation of airborne concentrations of radioactive materials, and exposures to hazardous substances. Rather than list the requirements to mitigate and control radiological and hazardous chemical exposures, the management plan references documents which provide the necessary direction to mitigate and control these hazards. To assist in the development of subtier or task-/subproject-specific implementation of the management system, the PHMC process for job hazards analysis will be used. The job hazards analysis process is a computer-based application to help planners identify the potential hazards associated with a job task, and to implement the proper controls based on the hazards identified. Proper use of the job hazards analysis process in conjunction with the project management system, plus specifics associated with the task, will constitute acceptable sub-tier or task-/subproject-specific implementation of the management system. In accordance with 29 CFR 1910.120(6)(1)(v), the management system shall be made available to PHMC employees and any contractor/subcontractor involved with hazardous waste operations.

The PHMC has a robust and mature radiation protection program that fully implements "Occupational Radiation Protection," as amended (10 CFR 835). The planning of work involving radiation and radioactive materials hazards is implemented through radiological work and radiation protection procedures. Procedures address roles and responsibilities, qualifications, training, implementation of the ALARA philosophy, external and internal dosimetry, monitoring and surveillance, work control mechanisms (e.g., radiation work permits, and access and entry requirements), self-assessments, and use of specific radiation monitoring devices and meters.

The PHMC chemical management process, in conjunction with implementation of the PHMC job hazard analysis process, will be relied upon to protect the worker, general public, and the environment from specific chemical substances and their associated hazards. The chemical management process provides direction for the acquisition, storage, transportation, use, final disposition, record keeping, and management review of program performance for chemicals at the Hanford Site.

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5.0 REFERENCES

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APPENDIX A

INFORMATION SUPPORTING DEVELOPMENT OF RADIONUCLIDE RATIOS FOR CHARACTERIZATION OF K BASIN DEBRIS AND ION EXCHANGE MODULES

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APPENDIX A

INFORMATION SUPPORTING DEVELOPMENT OF RADIONUCLIDE RATIOS FOR CHARACTERIZATION OF K BASIN DEBRIS AND ION EXCHANGE MODULES

The source-term for all of the radionuclides that could reasonably be expected in the K Basin is from N Reactor fuel and associated activation products. The selection of contaminants of concern (COC) was discussed in Appendix B of HNF-6273, *Data Quality Objectives Process for Designation of K-Basin Debris*. The selection was performed by listing all of the radionuclides that have been reported as present in the fuel or measured during historical characterization of the K East (KE), K West (KW), N, or 105-C fuel storage basins. Several selection criteria were applied to define the Environmental Restoration Disposal Facility (ERDF) Waste Acceptance Criteria (BHI-00139) that all "Radioactive waste constituents shall be adequately characterized to permit proper segregation, treatment, storage, and/or disposal. This characterization shall ensure that the major radionuclide content of the waste is known and recorded during the waste management process, . . ." (ERDF Waste Acceptance Criteria, Section 3.2.1.1). As a result of that effort, 20 radionuclide COCs were selected. The sections below discuss the application of radionuclide ratios to estimate the radionuclide content of K Basin debris for those radionuclides that are not measured from radionuclides that are measured.

A.1 RADIONUCLIDE RATIOS FOR CHARACTERIZATION OF K BASIN DEBRIS

Subsequent to the DQO report (HNF-6273), additional documents were obtained. These documents were entitled:

- HNF-SD-SNF-TI-009, *105-K Basin Material Design Basins Feed Description for Spent Nuclear Fuel Project Facilities*, Volume 1, "Fuel"
- HNF-SD-SNF-TI-009, *105-K Basin Material Design Basins Feed Description for Spent Nuclear Fuel Project Facilities*, Volume 2, "Sludge"
- HNF-SD-SNF-TI-015, *Spent Nuclear Fuel Project Databook, Vol. 2, Sludge.*

These documents formed the basis for the selection of radionuclide ratios for the purpose of estimating the radionuclide content of above and below water debris from the K Basin. WHC-SD-NR-RPT-005, *Characterization of Radioactive Waste at 100 Area*, contained extensive analyses of samples from the KE and KW Basin areas above the water line. These data provided valuable estimates of several radionuclides that had not been estimated from other sources (e.g., ^{59}Ni, ^{51}Cr, and ^{54}Mn). In order to put all of the radionuclides from the various sources on a normalized basis, all final estimates of radionuclide content of the fuel (HNF-SD-SNF-TI-009, Volume 1, "Fuel;" HNF-SD-SNF-TI-009, Volume 2, Sludge;" HNF-SD-SNF-TI-015) or samples from KW and KE Basins, were converted to a percent of the estimated ^{137}Cs concentration. For instance, if the reference indicated that the fuel would contain 500 Ci of ^{90}Sr and 1,000 Ci of ^{137}Cs, the percentage entered into Table A-1 for ^{90}Sr would be 50%.

In addition to the reports mentioned above there were several sampling efforts that had been conducted on various waste streams. The data from these various sampling efforts was tabulated and reviewed and ratios of each radionuclide measured were tabulated in Table A-1. Based on a review of the data from the various sources and the conceptual model for the waste stream it was determined that the following logic would be used to select the applicable ratio for each waste stream. Each basin, KW and KE, could have three sets of ratios that could be applied to the waste depending on the origin of the waste. These three sets of ratios are:

1. Ratios applicable to metallic waste that originated from below the water line of the basin and was washed before removing it from the water. The ratios used on this waste would be primarily fuel ratios (HNF-SD-SNF-TI-009, Volume 1, "Fuel") based on the data available and the conceptual model of how contamination occurred. Nondestructive assay (NDA) and laboratory results were also considered for this waste. Examples of this waste include fuel canisters, basin pipe racks, and any other pressure washed metal.

2. Ratios applicable to non-metallic or non-washed waste that originated from below the water line or the basin. The ratios used for this waste would be primarily those observed from measurement of basin floor sludge (HNF-SD-SNF-TI-015).

3. Ratios applicable to waste that originates from above the water line of the basin. The ratios used for this waste are primarily an amalgamation of data from WHC-SD-NR-RPT-005 and data from air sampling ("Facility Source Term Report," (Huntley 1999).

Additional discussion regarding the selection of applicable radionuclide ratios is provided below.

A.1.1 Below-Water Debris

The data reviewed and shown in Table A-1 indicated that washed metal items (e.g. pipe hangers and fuel canisters) more closely demonstrated the radionuclide ratios estimated for fuel (HNF-SD-SNF-TI-009, Volume 1, "Fuel"). If ratios of specific radionuclides to ^{137}Cs were available on samples applicable to a specific waste stream, the data were used. If no data were available, then ratios calculated from fuel (HNF-SD-SNF-TI-009, Volume 1, "Fuel") were used as appropriate. A decision was made to use KE below water washed metal debris ratios for both KE and KW below water washed metal debris (with the exception of washed aluminum canisters). This decision was based on KE fuel/canister transfers to KW basin and subsequent fuel cleaning activities. The previous KW washed metal ratios were based exclusively on KW fuel ratios which underestimated the TRU to ^{137}Cs ratios.

The ratios for below water washed aluminum canisters were derived from HNF-23774, *Contingency Sampling Work Plan for K Basins Aluminum Canisters*. Twelve aluminum canisters were washed using the routine canister cleaning system process and metal coupon samples were collected from each canister. The coupons were sent to the 222-S Laboratory for radiochemical analysis to determine the ratio of various isotopes, specifically comparing transuranic radionuclides to ^{137}Cs. The contingency sample results were supplemented with decay-corrected KE below-water washed metal ratios to develop the ratios in column 8, Table A-2.

For non-metal items or non-washed metal items, professional judgment determined that the most appropriate source term was basin floor sludge (HNF-SD-SNF-TI-009, Volume 2, "Sludge"). Radionuclide ratios were calculated using the appropriate tables in HNF-SD-SNF-TI-015 . If there were no sludge ratios available from either sample data or published sources, then fuel ratios were selected as default. In Table A-1 the available ratios that were deemed appropriate are tabulated along with a column that provides the chosen ratios for application to the K Basin debris.

In KW Basin, the canister and internal sludge are essentially homogeneous due to the fuel washing process. Since the startup of fuel cleaning and transfer operations, sludge material from the KE and KW canisters has been introduced into the KW floor. Therefore, KW floor sludge will be treated as KE canister sludge. KE north loadout pit (NLOP) sludge has been sampled and analyzed and varies markedly from KE floor sludge; therefore, unwashed metal and non-metal debris removed from the KE NLOP will be treated as KE NLOP sludge. Table A-2 provides a summary of the final selected ratios.

A.1.2 Above-Water Debris

Significant differences from radionuclide ratios found in fuel and found in KE versus KW were noted in historical analyses of samples from above water portions of the KE and KW (WHC-SD-NR-RPT-005). Another source of data that was used was the air sampling data from 1998 (Huntley 1999). Upon closer examination it was determined that the air filter data does not accurately reflect the above water contamination. Subsequently, the data from WHC-SD-NR-RPT-005 were used to determine the COC ratios. Not all of the COC radionuclides were measured on the samples from either source. If there were no measured ratios, then KW fuel data radionuclide ratios (HNF-SD-SNF-TI-009, Volume 1, "Fuel") or sludge data radionuclide ratios (HNF-SD-SNF-TI-015, Volume 2, "Sludge") were selected. Table A-2 provides a summary of the final selected radionuclide ratios. All ratios were decay corrected to January 1, 2005.

A decision was made to use KE above-water debris ratios for both KE and KW above-water debris. This decision was based on KE fuel/canister transfers to KW basin and subsequent fuel cleaning activities. The KE above-water debris ratios provide a worst-case bounding condition for both KE and KW above-water debris.

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Table A-1. Ratios of Measured Radionuclides.

Radionuclide Name	Radionuclide Symbol	KE Fuel COC Ratio % to ^{137}Cs[a]	Metal coupons from KE Pipes Ratio % to ^{137}Cs[b]	Pipe Smears from KE Ratio % to ^{137}Cs[c]	Canister NDA from KE Ratio % to ^{137}Cs[d]	Canister Smears from KE Ratio % to ^{137}Cs[d]	Ratio for KE/KW Below Water Washed Metal Debris	KE 60% Floor/40% Canister Sludge Ratio % to ^{137}Cs[e]	Ratio for KE Below Water Unwashed or Non-Metal Floor Debris	WHC Report KE Ratio % to ^{137}Cs[e,f]	Ratio for KE/KW Above Water Debris	KE Canister Sludge Ratio % to ^{137}Cs[e]	Ratio for KW Below Water Unwashed or Non-Metal Floor Debris	KE NLOP Sludge Ratio% to ^{137}Cs	Ratio for KE NLOP Below Water Unwashed or Non-Metal Floor Debris
Tritium	H-3	0.22%					0.22%	0.23%	0.23%	0.076%	0.076%	0.23%	0.23%	0.23%	0.23%
Cobalt	Co-60	0.013%	0.17%	0.67%	4.8%	0.88%	4.8%	0.10%	0.10%	0.058%	0.058%	0.043%	0.043%	0.84%	0.84%
Nickel	Ni-63	0.039%					0.039%	0.038%	0.038%	0.37%	0.37%	0.038%	0.038%	0.038%	0.038%
Strontium	Sr-90	76%					76%	149%	149%	102%	102%	177%	177%	38%	38%
Antimony	Sb-125	0.051%			1.05%		1.05%	0.067%	0.067%		0.067%	0.067%	0.067%	0.067%	0.067%
Cesium	Cs/Ba-137m	100%	100%	100%		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Promethium	Pm-147	0.69%					0.69%	0.86%	0.86%		0.86%	0.86%	0.86%	0.86%	0.86%
Samarium	Sm-151	1.51%					1.5%	1.5%	1.5%		1.5%	1.46%	1.46%	1.46%	1.46%
Europium	Eu-152	0.0058%					0.0058%	0.013%	0.013%		0.013%	0.0096%	0.0096%	0.016%	0.016%
Europium	Eu-154	0.54%	0.28%	0.74%	1.95%	1.2%	1.95%	1.21%	1.21%		1.21%	0.92%	0.92%	1.56%	1.56%
Europium	Eu-155	0.070%	0.41%	0.28%	0.97%	0.40%	0.97%	0.67%	0.67%		0.67%	0.33%	0.33%	0.39%	0.39%
Uranium	U-234	0.0083%					0.0083%	0.029%	0.029%	0.03%	0.030%	0.042%	0.042%	0.037%	0.037%
Uranium	U-235	0.00030%					0.00030%	0.00087%	0.00087%	0.0052%	0.0052%	0.0013%	0.0013%	0.0014%	0.0014%
Uranium	U-238	0.0068%					0.0068%	0.020%	0.020%	0.024%	0.024%	0.030%	0.030%	0.030%	0.030%
Plutonium	Pu-238	1.03%	0.14%				1.03%	1.9%	1.9%	2.26%	2.26%	2.52%	2.52%	4.24%	4.24%
Plutonium	Pu-239	2.13%	0.8%				2.13%	7.3%	7.3%	14.6%	14.6%	10.3%	10.3%	21.1%	21.1%
Plutonium	Pu-240	1.12%					1.12%	4.0%	4.0%		4.0%	5.63%	5.63%	11.6%	11.6%
Plutonium	Pu-241	44%					44%	214%	214%	174%	174%	217%	217%	489%	489%
Americium	Am-241	9.53%	1.6%	5.4%		7.9%	9.53%	9.3%	9.3%	20.5%	20.5%	15.7%	15.7%	32.1%	32.1%
Curium	Cm-244	0.012%					0.012%	0.025%	0.025%		0.025%	0.042%	0.042%	0.087%	0.087%

Notes:

[a] Data from Table 3.6 "105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities, Volume 1, Fuel" HNF-SD-SNF-TI-009, Volume 1, Rev. 3.

[b] Metal coupons cut from three fuel storage hangers in KE. Data reference Memo from Jeff Huisingh to R. M. Jochen, "222-S Final Hanger Coupon Analysis and Rad Survey Reports".

[c] Data reports from the SNF Facility Operations Counting Facility. Gamma Energy Analysis dated 1/10/97.

[d] "Characterization of Empty Fuel Storage Canisters in 105 KE Basin", WHC-SD-SNF-TI-019, author Jeremy B. Crystal.

[e] "Spent Nuclear Fuel Project Databook, Volume 2, Sludge", HNF-SD-SNF-TI-015, Rev. 12.

[f] "Characterization of Radioactive Waste at 100 Area", WHC-SD-NR-RPT-005, Rev. 0, author John DeVanney.

COC = contaminant of concern.

KE = K East.

KW = K West.

NDA = nondestructive assay.

NLOP = north loadout pit.

WHC = Westinghouse Hanford Company.

Table A-2. Summary List of Radionuclide Contaminants of Concern and Ratios to ^{137}Cs for K Basin Waste.

Radionuclide Name	Radionuclide Symbol	Ratio for KE/KW Below Water Washed Metal Debris	Ratio for KE Below Water Unwashed or Non-Metal Debris (except KE NLOP)	Ratio for KE/KW Above Water Debris	Ratio for KW Below Water Unwashed or Non-Metal Debris	Ratio for KE Unwashed or Non-Metal Debris Removed From KE NLOP	Ratio for Washed Aluminum Canisters
Column 1	**Column 2**	**Column 3**	**Column 4**	**Column 5**	**Column 6**	**Column 7**	**Column 8**
Tritium	H-3	0.22%	0.23%	0.076%	0.23%	0.23%	0.22%
Cobalt	Co-60	4.8%	0.10%	0.058%	0.043%	0.84%	0.13%
Nickel	Ni-63	0.039%	0.038%	0.37%	0.038%	0.038%	0.039%
Strontium	Sr-90	76%	149%	102%	177%	38%	95.3%
Antimony	Sb-125	1.05%	0.067%	0.067%	0.067%	0.067%	1.05%
Cesium	Cs/Ba-137m	100%	100%	100%	100%	100%	100%
Promethium	Pm-147	0.69%	0.86%	0.86%	0.86%	0.86%	0.69%
Samarium	Sm-151	1.51%	1.5%	1.5%	1.46%	1.46%	1.51%
Europium	Eu-152	0.0058%	0.013%	0.013%	0.0096%	0.016%	0.0058%
Europium	Eu-154	1.95%	1.21%	1.21%	0.92%	1.56%	0.37%
Europium	Eu-155	0.97%	0.67%	0.67%	0.33%	0.39%	0.97%
Uranium	U-234	0.0083%	0.029%	0.030%	0.042%	0.037%	0.08%
Uranium	U-235	0.00030%	0.00087%	0.0052%	0.0013%	0.0014%	0.00030%
Uranium	U-238	0.0068%	0.02%	0.024%	0.030%	0.030%	0.068%
Plutonium	Pu-238	1.03%	1.9%	2.26%	2.52%	4.24%	0.82%
Plutonium	Pu-239	2.13%	7.3%	14.6%	10.3%	21.1%	1.74%
Plutonium	Pu-240	1.12%	4.0%	4.0%	5.63%	11.6%	2.30%
Plutonium	Pu-241	44%	214%	174%	217%	489%	44.1%
Americium	Am-241	9.53%	9.3%	20.5%	15.7%	32.1%	5.2%
Curium	Cm-244	0.012%	0.025%	0.025%	0.042%	0.087%	0.012%

Notes:

KE = K East.
KW = K West.
NLOP = north loadout pit.

A.2 RADIONUCLIDE RATIOS FOR CHARACTERIZATION OF K BASIN ION EXCHANGE MODULES

The current process for estimating the radionuclide content of ion-exchange modules (IXM) that have been removed from service is generally described in the HNF-SD-SNF-TI-039, *Characterization Plan for Spent KE Basin Ion Exchange Modules*. The characterization methodology described in that document uses ^{137}Cs and total alpha to calculate by ratio, the inventory of all reportable radionuclides in the IXM. Radionuclide ratios for radionuclides measured were obtained from previous process data. The end result was an approach that estimated the radionuclide loading of the IXMs solely from gross alpha and ^{137}Cs data. The current approach has been modified from the initial characterization plan. The current method uses monthly IXM inlet and outlet data containing additional analytical results from several more of the COCs ($^{239/240}Pu$, ^{238}Pu, ^{90}Sr, tritium, ^{234}U, ^{235}U, ^{238}U and ^{241}Am).

The Hanford Site waste acceptance document (HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*) has deleted the Appendix K tables that were still used. In addition, as discussed in the sections above, a new document that describes the specific fuel source terms in the K Basin in detail has become available (HNF-SD-SNF-TI-009, Volume 1, "Fuel"). The data used to establish new ratios include the new fuel source term data (HNF-SD-SNF-TI-009, Volume 1, "Fuel") and 12 routine monthly KE IXM inlet and outlet samples collected in KE and KW January 2004 to December 2004 and 4 routine monthly KW IXM inlet and outlet samples collected from August 2004 to November 2004.

Table A-3 lists the K Basin fuels data for both KE and KW as well as the average of the monthly IXM inlet and outlet samples. All of the data has been converted to a percentage of the estimated ^{137}Cs activity for ease of comparison.

In general application, the results of all of the radionuclides that are measured will be used directly. Those that are not measured will be estimated by applying the ratios in Table A-3 to those radionuclides that are measured. In the case of $^{239/240}Pu$, the isotopic mix for plutonium isotopes that is provided in the fuel (HNF-SD-SNF-TI-009, Volume 1, "Fuel") is applied to the measured $^{239/240}Pu$ in order to estimate individual plutonium isotopes. The ^{238}Pu isotope measured is often very low and, thus, if the data are censored and the detection limit data are used, the estimate will be a significant overestimate of ^{238}Pu in the water. If ^{238}Pu levels in the water are below detection limits, then the $^{239/240}Pu$ data and predicted isotopic ratios from fuel are used to predict the ^{238}Pu concentrations in the water. The uranium concentrations for each uranium COC isotope are reported by the laboratory and are measured using inductively coupled plasma/mass spectroscopy. ^{63}Ni, ^{125}Sb, ^{147}Pm, ^{151}Sm, and ^{244}Cm are estimated by assuming that the ratio percent in the water is the same as in the fuel.

Tritium is not concentrated by the ion exchange resin and is not currently reported as a waste constituent in the IXMs. However since tritium is a COC identified in this Sampling and Analysis Plan (SAP) and data are available from the analytical results of the monthly IXM inlet and outlet water samples, it will be reported in IXMs characterized under this SAP. Recent calculations (Appendix B) have estimated the maximum amount of water that is likely to be held up in the IXM after it is drained and sealed. These calculations will be used to establish a direct calculation that relates the measured or estimated concentration of tritium to the total amount of tritium that is held up in the IXM. The calculations in Appendix B that estimate the maximum amount of water in the IXM will be used to establish that factor.

The approach applied through this SAP will employ the same general radiochemical analysis and spreadsheet currently used and utilizes the radionuclide measurements that are performed on the basin water during the operational life of the IXM. Ratios that have been measured on monthly basin water samples in 2004 by the Waste Sampling and Characterization Facility Laboratory are shown for comparison and for use if analytical data are not available for specific radionuclides. The estimate of radionuclide content for the IXMs may be based on the radionuclide concentration that are measured in the center of basin samples or a net (inlet-outlet) water concentration. The estimated concentration in the water is combined with the total measured flow or maximum system flow if measured flow is not available of basin water through the IXM. The calculation that is currently used has locations to enter the flow rate, time of service and subsequently calculate the estimated total curies of radionuclide using the IXM flow rate data and analytical results (sheet 2 and 3 in the current spreadsheet). The current calculation worksheet labeled "Determine (KE or) KW IXM Rad Inventory." provides the applicable ratios to estimate radionuclides other than those measured. The current calculation will be placed into applicable procedures to include the COCs ratios that are listed in Table A-3 and to include a calculation for the tritium content of the IXM.

The major changes for IXMs characterized under this SAP are that gross alpha measurements are not used to estimate radionuclide content of the IXM, tritium will be reported, and new radionuclide ratios will be used for those radionuclides not measured based on revised fuel source terms and water data.

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Table A-3. Comparison of Ion Exchange Module Water Ratios and Historical Ratios and Final Recommended Ratios.

Radionuclide Name	Radionuclide Symbol	Fuel[a] KE Ratio % to ^{137}Cs	Water[b] 2004 Ave KE Ratio % of ^{137}Cs	Proposed Water Ratios for KE IXM Charac. % of ^{137}Cs	Fuel[c] KW Ratio % to ^{137}Cs	Water 2004 Ave KW Ratio % of ^{137}Cs	Proposed Water Ratios for KW IXM Charac. % of ^{137}Cs
Tritium	H-3	0.22%	130%	130%	0.22%	213%	213%
Cobalt	Co-60	0.013%	0.055%	0.055%	0.015%		0.015%
Nickel	Ni-63	0.04%		0.04%	0.037%		0.037%
Strontium	Sr-90	76%	23%	23%	76%	200%	200%
Antimony	Sb-125	0.051%		0.051%	0.051%		0.051%
Cesium	Cs/Ba-137m	100%	100%	100%	100%	100%	100%
Promethium	Pm-147	0.69%		0.69%	0.60%		0.60%
Samarium	Sm-151	1.51%		1.51%	1.40%		1.40%
Europium	Eu-152	0.006%		0.006%	0.006%		0.006%
Europium	Eu-154	0.54%		0.54%	0.54%		0.54%
Europium	Eu-155	0.070%		0.07%	0.070%		0.07%
Uranium	U-234	0.008%	0.006%	0.006%	0.007%	0.05%	0.05%
Uranium	U-235	0.00%	0.0012%	0.0012%	0.00%	0.01%	0.01%
Uranium	U-238	0.007%	0.0024%	0.0024%	0.006%	0.02%	0.02%
Plutonium	Pu-238	1.03%	0.062%	0.062%	0.85%	0.04%	0.04%
Plutonium	Pu-239/240	3.25%	0.43%	0.43%	2.78%	0.33%	0.33%
Plutonium	Pu-239	2.13%		0.29%	1.80%		0.22%
Plutonium	Pu-240	1.12%		0.14%	0.98%		0.11%
Plutonium	Pu-241	44%		5.8%	41%		4.9%
Americium	Am-241	9.53%	0.44%	0.44%	3.2%	0.27%	0.27%
Curium	Cm-244	0.012%		0.012%	0.008%		0.008%

Table A-3. Comparison of Ion Exchange Module Water Ratios and Historical Ratios and Final Recommended Ratios.

Radionuclide Name	Radionuclide Symbol		Fuel[a] KE Ratio % to ^{137}Cs	Water[b] 2004 Ave KE Ratio % of ^{137}Cs	Proposed Water Ratios for KE IXM Charac. % of ^{137}Cs		Fuel[c] KW Ratio % to ^{137}Cs	Water 2004 Ave KW Ratio % of ^{137}Cs	Proposed Water Ratios for KW IXM Charac. % of ^{137}Cs

Notes:

[a]Data from HNF-SD-SNF-TI-009, Volume 1, "Fuel," Table 3.6.

[b]Average of 2004 Routine Monthly water samples, Jan-Dec.

[c]Data from HNF-SD-SNF-TI-009, Volume 1, "Fuel," Table 3.7.

HNF-SD-SNF-TI-009, 2000, *105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities*, Rev. 3, Volume 1, "Fuel," Fluor Hanford, Richland, Washington.

IXM = ion exchanges module.

KE = K East.

KW = K West.

A.3 REFERENCES

BHI-00139 as amended, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Bechtel Hanford, Inc., Richland, Washington.

HNF-EP-0063 as amended, *Hanford Site Solid Waste Acceptance Criteria*, Fluor Hanford, Richland, Washington.

HNF-6273, 2000, *Data Quality Objectives Process for Designation of K-Basin Debris*, Rev. 0, Fluor Hanford, Richland, Washington.

HNF-23774, 2004, *Contingency Sampling Work Plan for K Basins Aluminum Canisters*, Rev. 1, Fluor Hanford, Richland, Washington.

HNF-SD-SNF-TI-009, 2000, *105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities*, Rev. 3, Volume 1, "Fuel," Fluor Hanford, Richland, Washington.

HNF-SD-SNF-TI-009, 2000, *105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities*, Rev. 3, Volume 2, "Sludge," Fluor Hanford, Richland, Washington.

HNF-SD-SNF-TI-015, 2004, *Spent Nuclear Fuel Project Databook Vol. 2, Sludge*, Rev. 12, Fluor Hanford, Richland, Washington.

Huntley 1999, "*Facility Source Term Report*," 99-SNF/CJS-024, Interoffice Correspondence from P.G. Huntley to C. J. Slotemaker, dated March 29, 1999.

WHC-SD-NR-RPT-005, 1990, *Characterization of Radioactive Waste at 100 Area*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-SNF-TI-039, 1997, *Characterization Plan for Spent KE Basin Ion Exchange Modules*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX B

ESTIMATED TRITIUM CONTENT IN SPENT 100 K ION EXCHANGE MODULES

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APPENDIX B

ESTIMATED TRITIUM CONTENT IN SPENT 100 K ION EXCHANGE MODULES

The calculations below provide a basis for estimating the water content of the drained ion exchange modules (IXM). The example shown below estimates the maximum tritium content of an IXM from the maximum tritium content measured in K East (KE) Basin water over the time period indicated. The calculation is shown to demonstrate the likely upper bound of tritium in an IXM. For purposes of waste characterization under this SAP, the estimate of 501.8 kg of water in the resin and 24.3 kg of water in the bottom of the IXM will be used in conjunction with the measured tritium concentration in the basin water over the life of the IXM to obtain an accurate accounting of the ^3H in an IXM. As discussed in Appendix A, Section A.2, this calculation will be integrated into the current spreadsheet used to estimate radionuclide content of the total IXM package.

These estimates of water in the IXM package will be valid unless there is a configuration change or a change in the type of resin that is in the IXM.

Assumptions:

1. IXM Mixed Bed (MB) Volume = 6 vessels/IXM X 3.5 ft^3/vessel = 30 ft^3

2. 100KE basin uses Purolite MB resin NRW-35 which consists of 60% by volume (A-600) anion and 40% resin by volume cation resin

3. The 80% moisture content is higher than Purolite mfg. Literature indicated

4. The maximum tritium conc. used is from 100KE basin which is typically two orders of magnitude higher than for 100KW basin

   46 lbs./ft^3 X 30 ft^3 = 1,380 lbs.(627.3 kg)

   80%(moisture content of resin beads) X 627.3 kg = 501.8 kg of water

   3.44E-3 μCi/gm (maximum basin water tritium conc. '95-'99) X 5.02E+5 gm = 1.73E+3 μCi or 1.73E-3 Ci

5. Total volume of IXM including the concrete = 7.83 M^3

   2.21E-4 Ci/M^3 (tritium conc. In moisture trapped in MB resin beads including the concrete volume)

The volume of water remaining in the bottom of each vessel was previously estimated to be

246 in^3/vessel X 6 = 1,480 in^3 or 2.43E+1 Liters

3.44E+0 μCi/L (maximum basin water tritium conc. '95-'99) X 2.43E+1 Liters = 8.36E+1 μCi or 8.36E-5 Ci

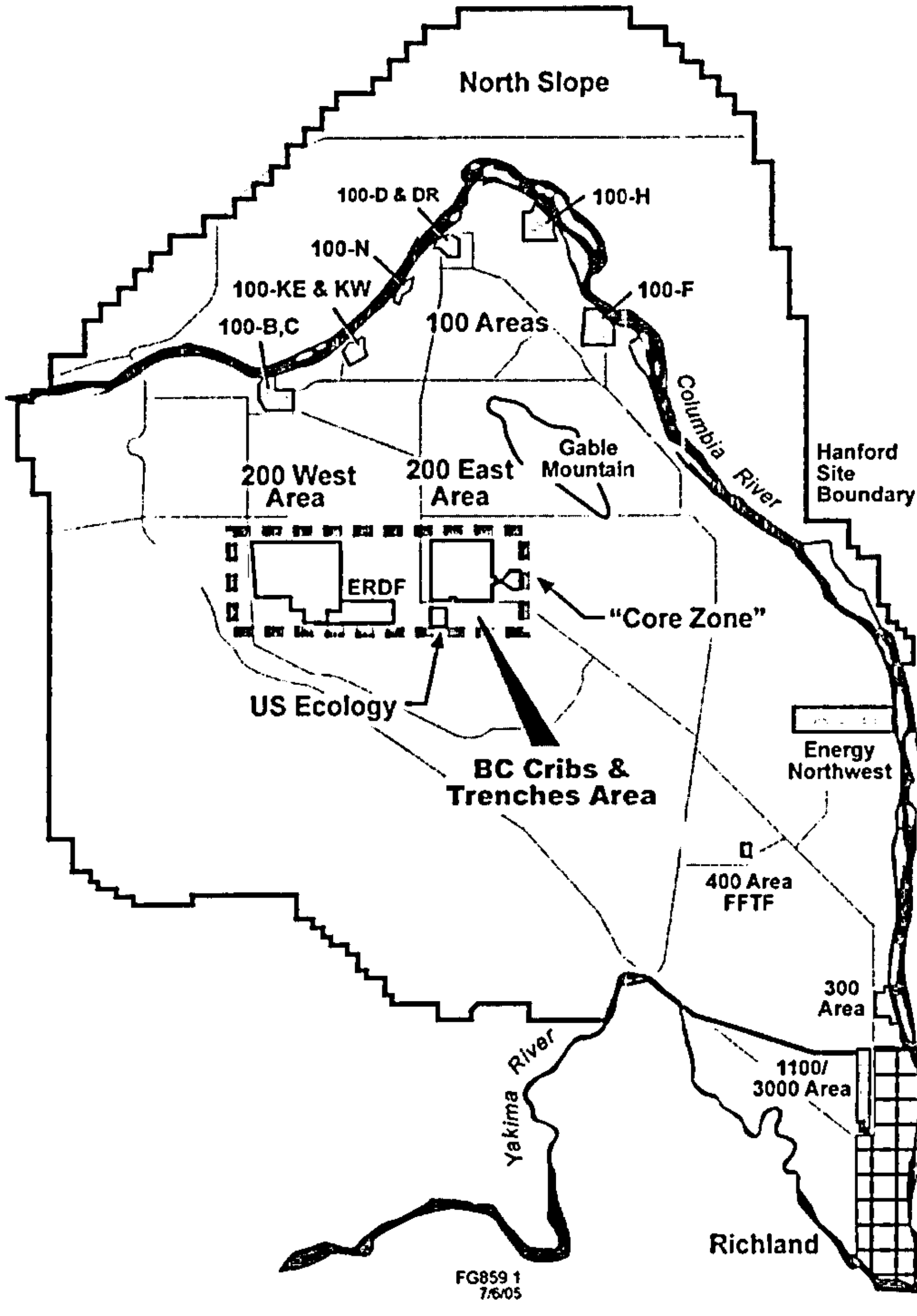
Therefore,

1.81E-3 Ci = Total Estimated tritium in a spent IXM (includes water in the resin plus water remaining in bottom of vessel)

Calculation done by: Bill Klover Date: 03/06/'00

Reviewed by: Rod Jochen Date: 03/06/'00

Figure 1-1. Location of the Hanford Site and BC Cribs and Trenches Area.



Core Zone corresponds to the industrial-exclusive boundary defined by DOE/EIS-0222-F, Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement and the Record of Decision (54 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Environmental Impact Statement)